National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Consultation on the Issuance of 24 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, Idaho, and California affecting Salmon, Steelhead, Eulachon, Green Sturgeon, and Rockfish in the West Coast Region

NMFS Consultation Number: WCRO-2020-03672
ARN 151422WCR2021PR00054

Action Agencies: The National Marine Fisheries Service (NMFS)
Northwest Fisheries Science Center (NWFSC)
Southwest Fisheries Science Center (SWFSC)
The Interagency Ecological Program (IEP)
The United States Forest Service (USFS)
The Bureau of Indian Affairs (BIA)
The Bonneville Power Administration (BPA)
The United States Fish and Wildlife Service (USFWS)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound (PS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
PS steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Puget Sound/Georgia Basin (PS/GB) bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	No	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	No	No
Hood Canal summer-run (HCS) chum salmon (*O. keta*)	Threatened	Yes	No	No	No
Upper Columbia River (UCR) spring-run Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	No	No

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Upper Columbia River (UCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Middle Columbia River (MCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Snake River (SnkR) spring/summer-run (spr/sum) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Snake River (SnkR) fall-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Snake River (SnkR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Snake River (SnkR) sockeye salmon (*O. nerka*)	Endangered	Yes	No	No	No
Lower Columbia River (LCR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Lower Columbia River (LCR) coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
Lower Columbia River (LCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Columbia River (CR) chum salmon (*O. keta*)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Oregon Coast (OC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
Southern Oregon/Northern California Coast (SONCC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
Northern California (NC) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
California Coastal (CC) Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Sacramento River (SacR) winter-run Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	No	No
Central Valley spring-run (CVS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
California Central Valley (CCV) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Central California Coast (CCC) coho salmon (*O. kisutch*)	Endangered	Yes	No	No	No
Central California Coast (CCC) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
South-Central California Coast (SCCC) Steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Southern California (SC) steelhead (*O. mykiss*)	Endangered	Yes	No	No	No
Southern (S) eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No	No
Southern DPS green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No	No
Southern Resident (SR) killer whale (*Orcinus orca*)	Endangered	No	No	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	No	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: Chris E Yates

Chris Yates
Assistant Regional Administrator for Protected Resources

Date: March 30, 2020

TABLE OF CONTENTS

List of Acronyms

AMIP – Adaptive Management and Implementation Plan
ARIS – Adaptive Resolution Imaging Sonar
ARN – Administrative Record Number
BIA – Bureau of Indian Affairs
BPA – Bonneville Power Administration
C/H/R – Capture/Handle/Release
C/M, T, S/R – Capture/Mark, Tag, Sample Tissue/Release Live Animal
CC – California Coastal
CCC – Central California Coast
CDFW – California Department of Fish and Wildlife
CFR – Code of Federal Regulation
CH – Critical Habitat
CHART – Critical Habitat Analytical Review Teams
CR – Columbia River
CTWS – Confederated Tribes of Warm Springs
CVS – Central Valley spring-run
CWT – Coded Wire Tag
DC – Direct Current
DEQ – Oregon Department of Environmental Quality
DFO – Department of Fisheries and Oceans
DIDSON – Dual Frequency Identification Sonar
DPS – Distinct Population Segment
DQA – Data Quality Act
EFH – Essential Fish Habitat
EPA – Environmental Protection Agency
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
HCS – Hood Canal summer-run
HUC5 – Hydrologic Unit Code (fifth-field)
ICTRT – Interior Columbia Technical Recovery Team
IDFG – Idaho Department of Fish and Game
IM – Intentional (Directed) Mortality
IPC – Idaho Power Company
ITS – Incidental Take Statement
KCDNRP – King County Department of Natural Resources and Parks
LCR – Lower Columbia River
LHAC – Listed Hatchery Adipose Clipped
LHIA – Listed Hatchery Intact Adipose
MCR – Middle Columbia River
MPG – Major Population Group
MR – Merrill & Ring
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NCASI – National Council of Air and Stream Improvements

NFH – National Fish Hatchery
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NWFSC – Northwest Fisheries Science Center
O/H – Observe/Harass
OC – Oregon Coast
ODFW – Oregon Department of Fish and Wildlife
OL – Ozette Lake
PBF – Physical or Biological Features
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PIT – Passive Integrated Transponder
PS – Puget Sound
PS/GB – Puget Sound/Georgia Basin
PSI – Pacific Shellfish Institute
PTI – Puyallup Tribe of Indians
RK – River Kilometer
ROV – Remotely Operated Vehicle
RPM – Reasonable and Prudent Measure
S – Southern
SacR – Sacramento River
SBT – Shoshone-Bannock Tribes
SnkR – Snake River
SONCC – Southern Oregon/Northern California Coast
spr/sum – spring/summer run
SR – Southern Resident
TRT – Technical Recovery Team
UCR – Upper Columbia River
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service
USGS –United States Geological Survey
UW – University of Washington
UWR – Upper Willamette River
VSP – Viable Salmonid Population
WCR – West Coast Region
WDFW – Washington Department of Fish and Wildlife
WDNR – Washington Department of Natural Resources
WFC – Wild Fish Conservancy

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended. It constitutes a review of 24 scientific research permits NMFS is proposing to issue under section 10(a)(1)(A) of the ESA and is based on information provided in the associated applications for the proposed permits, published and unpublished scientific information on the biology and ecology of listed salmonids in the action areas, and other sources of information.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository. A complete record of this consultation is on file at the Protected Resources Division in Portland, OR.

1.2 Consultation History

The West Coast Region's (WCR's) Protected Resources Division (PRD) received 24 applications for permits to conduct scientific research in Washington, Oregon, Idaho, and California (see Table 1 and the text following it):

- Sixteen applications were to renew existing permits,
- Two applications were to modify existing permits, and
- Six applications were for new permits.

Because the permit requests are similar in nature and duration and are expected to affect many of the same listed species, we combined them into a single consultation pursuant to 50 CFR 402.14(c). The affected species are:

- Chinook salmon
    - Puget Sound (PS)
    - Upper Columbia River (UCR) spring-run
    - Snake River (SnkR) fall-run
    - Snake River (SnkR) spring/summer run

  - Lower Columbia River (LCR)
  - Upper Willamette River (UWR)
  - Sacramento River winter-run (SRWR)
  - California Coastal (CC)
  - Central Valley spring-run (CVS)
- Coho salmon
  - Lower Columbia River (LCR)
  - Oregon Coast (OC)
  - Southern Oregon/Northern California Coast (SONCC)
  - Central California Coast (CCC)
- Chum salmon
  - Hood Canal summer-run (HCS)
  - Columbia River (CR)
- Sockeye salmon
  - Snake River (SnkR)
- Steelhead
  - Puget Sound (PS)
  - Upper Columbia River (UCR)
  - Middle Columbia River (MCR)
  - Deschutes River Non-essential Experimental Population (NEP) of Middle Columbia River (MCR)
  - Snake River Basin (SnkR)
  - Lower Columbia River (LCR)
  - Upper Willamette River (UWR)
  - Northern California (NC)
  - California Central Valley (CCV)
  - Central California Coast (CCC)
  - South-Central California Coast (SCCC)
  - Southern California (SC)
- Southern (DPS) Eulachon
- Southern DPS (SDPS) Green sturgeon
- Puget Sound/Georgia Basin Boccacio (PS/GB)
- Puget Sound/Georgia Basin yelloweye rockfish (PS/GB)

The proposed actions also have the potential to affect Southern Resident (SR) killer whales and their critical habitat by diminishing the whales' prey base. We concluded that the proposed activities are not likely to adversely affect SR killer whales or their critical habitat and the full analysis for that conclusion is found in the "Not Likely to Adversely Affect" Determination section (2.11).

Table 1. The Applications Considered in this Biological Opinion—and Their Associated Applicants.

Permit Number	Applicant
1415-5R	U.S. Fish and Wildlife Service (USFWS)
1440-3R	Interagency Ecological Program (IEP)

Permit Number	Applicant
13675-3R	Fishery Foundation of California
15486-3R	West Fork Environmental, Inc. (WFE)
15549-3R	Columbia River Inter-Tribal Fish Commission (CRITFC)
15611-3R	Washington Department of Fish and Wildlife (WDFW)
16274-2R	Mendocino Redwood Company (MRC)
17077-3R	University of California at Davis (UC Davis)
17219-3R	NMFS's Southwest Fisheries Science Center (SWFSC)
17351-2R	Green Diamond Resource Company
18696-5M	Idaho Power
18908-2R	Skagit Fisheries Enhancement Group (SFEG)
19320-2R	The SWFSC
19738-2R	Washington Department of Natural Resources (WADNR)
19741-2R	Confederated Tribes and Bands of Yakama Nation (YN)
22482-2R	NMFS's Northwest Fisheries Science Center (NWFSC)
23029-2R	The NWFSC
23649-2M	Mount Hood Environmental (MHE)
24151	U.S. Forest Service (USFS) - PNW Research Station
24255	California Department of Fish and Wildlife (CDFW)
24367	The NWFSC
25409	Oregon State University (OSU) Department of Fisheries and Wildlife
25463	Moss Landing Marine Labs (MPSL)
25466	TRPA Fish Biologists

Permit 1415-5R – We received a permit renewal request 1415-5R from the U.S. Fish and Wildlife Services' Red Bluff Fish and Wildlife Office on August 12, 2020. Requested edits were sent and addressed, and the application was completed on February 16, 2021.

Permit 1440-3R – We received a permit renewal request 1440-3R from the Interagency Ecological Program on December 22, 2020. Requested edits were sent and addressed, and the application was completed on February 16, 2021.

Permit 13675-3R – We received a permit renewal request 13675-3R from the Fishery Foundation of California on October 9, 2020. Requested edits were sent and addressed, and the application was completed on February 16, 2021.

Permit 15486-3R – We received a permit renewal request from West Fork Environmental on 8/28/2020. Requested edits were sent and addressed and, after further clarification regarding where and when the proposed work would take place, the application was deemed complete on 1/15/2021.

Permit 15549-3R – We received a permit renewal request from the Columbia River Inter-Tribal Fish Commission on 11/12/2020. Requested edits were sent and addressed and final authentication was received on 12/17/2020—making the application complete at that time.

Permit 15611-3R – We received a permit renewal request from WDFW on 10/27/2020. Requested edits were sent and addressed and, and after further clarification regarding where and when the proposed work would take place, the application was deemed complete on 01/08/2021.

Permit 16274-2R –
We received a permit renewal request 16274-2R from the Mendocino Redwood Company on July 13, 2020. Requested edits were sent and addressed, and the application was completed on February 16, 2021.

Permit 17077-3R – We received a permit renewal request 17077-3R from the University of California at Davis on March 2, 2020. Requested edits were sent and addressed, and the application was completed on February 16, 2021.

Permit 17219-3R – We received a permit renewal request 17219-3R from the NMFS Southwest Fisheries Science Center on December 16, 2020. Requested edits were sent and addressed, and the application was completed on February 16, 2021.

Permit 17351-2R – We received a permit renewal request 17351-2R from Green Diamond Resource Company on September 28, 2020. Requested edits were sent and addressed, and the application was completed on Feb 16, 2021.

Permit 18696-5M – We received a request to modify Permit 18696 from Idaho Power on 10/27/2020. After further clarification and edits, the application was deemed complete on 01/05/2021.

Permit 18908-2R – We received a permit renewal request from the SFEG on December 17, 2020. Requested edits were sent and addressed and the application was completed on February 3, 2021.

Permit 19320-2R – We received a permit renewal request from the SWFSC on 01/08/2021. Requested edits were sent and addressed, and the application was deemed complete on 01/12/2021.

Permit 19738-2R – We received a permit renewal request from the WA DNR on March 3, 2020. Review of the application found no additional edits were needed, and the application was deemed complete on January 26, 2021.

Permit 19741-2R – We received a permit renewal request from the YN on 08/25/2020. Requested edits were sent and addressed, and the application was deemed complete on 10/21/2020.

Permit 22482-2R – We received a permit renewal request from the NWFSC on 01/07/2021]. Requested edits were sent, addressed, and the application was completed on [DATE].

Permit 23029-2R – We received a permit renewal request from the NWFSC on January 5, 2021. We reviewed the application and requested clarification on the relationship between this work and other Federal actions requiring ESA consultation on January 29, 2021. The NWFSC provided additional information on February 2, 2021, and the application was deemed complete on February 3, 2021.

Permit 23649-2M – We received a request to modify Permit 23649 from MHE on 12/31/2020. Because the researchers had communicated about the permit with NMFS a number of times before that date, the application was deemed complete at the time it was submitted.

Permit 24151 – We received a permit request from the USFS on 9/16/2020. We reviewed the application and we deemed the application complete on 9/21/2020.

Permit 24367 – We received a permit request from the NWFSC on November 17, 2020. We reviewed the application and requested additional information from the applicants on January 29, 2021. The NWFSC provided additional information and resubmitted their application on February 9, 2021. We deemed the application complete February 9, 2021.

Permit 24255 – We received a permit request 24255 from California Department of Fish and Wildlife on October 2, 2020. We participated in multiple calls with the applicant to address questions prior to the application submittal. We deemed the application complete on February 16, 2021.

Permit 25409 – We received a permit request from OSU on 12/28/2020. We reviewed the application and requested additional information and, once that was received, the application was deemed complete on 1/25/2021.

Permit 25463 – We received a permit request 25463 from Moss Landing Marine Labs, MPSL on December 23, 2020. We participated in multiple calls with the applicant to address questions prior to the application submittal. We deemed the application complete on February 16, 2021.

Permit 25466 – We received a permit request 25466 from TRPA Fish Biologists on December 16, 2020. We deemed the application complete on February 16, 2021.

Most of the requests were deemed incomplete to varying extents when they arrived. After numerous phone calls and e-mail exchanges, the applicants revised and finalized their applications. After the applications were determined to be complete, we published notice in the Federal Register on

February 16, 2021 asking for public comment on them (86 FR 9490). The public was given 30 days to comment on the permit applications and, once the comment period periods closed on March 18, 2021, the consultation was formally initiated on March 19, 2021. The full consultation histories for the actions are lengthy and not directly relevant to the analysis for the proposed actions and so are not detailed here. A complete record of this consultation is maintained by the PRD and kept on file in Portland, Oregon.

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

Under the MSA, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).]

The proposed action here is for NMFS to issue 24 scientific research permits pursuant to section 10(a)(1)(A) of the ESA. The permits would cover the research activities proposed by the applicants listed in Table 1, above. The permits would variously authorize researchers to take all the species listed on the front page of this document (except southern resident killer whales). "Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct.

We considered, under the ESA, whether the proposed action would cause any other activities and determined that it would not.

Permit 1415-5R

The U.S. Fish and Wildlife Service's Red Bluff Office is seeking to renew a permit that allows them to annually take juvenile and adult SacR winter-run and CVS Chinook salmon, adult and juvenile CCV steelhead, and egg, larval, and juvenile SDPS green sturgeon in the Sacramento River and in Clear and Battle Creeks in the Central Valley, California. This permit renewal would cover nine research projects carried out by the USFWS Red Bluff office. The names and purposes of the nine studies are: (1) Battle Creek Fish Community Structure Evaluation (Pre/Post-Restoration)—the primary goal of this study is to assess how fish community distribution changes in response to the restoration project. (2) Battle Creek Juvenile Salmonid Monitoring Project—the goal is to monitor annual juvenile production and develop production indices, assess restoration efforts, and gather information on the history and migration of juvenile salmonids. (3) Battle Creek Adult Salmonid Monitoring Project—the purpose is to monitor escapement, migration timing, and population distribution of adult spring run and steelhead. (4) Battle Creek emergence trapping—the purpose is to monitor fry emergence in conjunction with the Battle Creek winter-run Jumpstart Project and Reintroduction Program efforts. (5) Clear Creek Juvenile Salmonid Monitoring Project—the purpose is to monitor juvenile Chinook and steelhead production, size, condition, and environmental data with the goal of information restoration actions in Clear Creek. (6) Clear Creek Fish Restoration Program Monitoring—the purpose is to monitor restored stream channel form and function (i.e., improved water quality and quantity, reduced sedimentation, etc.). (7) Sacramento River Juvenile

Fish Monitoring at Red Bluff Diversion Dam (RBDD)—the primary objectives of this project are to (a) obtain juvenile winter Chinook production indices and to correlate these indices with estimated escapement from adult estimates provided by the winter Chinook carcass survey, (b) define seasonal and temporal patterns of abundance of winter, spring, fall and late-fall run Chinook salmon and steelhead trout passing the RBDD, and (c) obtain relative abundance information for green sturgeon and lamprey to monitor trends in abundance. (8) Life History Studies on the Sacramento River SDPS green sturgeon—the goal is to identify spawning habitat and larval and monitor juvenile rearing and migration movements in the Sacramento River. (9) Sacramento River Winter Chinook Salmon Carcass Survey—the carcass survey would help managers estimate the annual abundance of winter Chinook salmon spawners. Estimates of abundance would be made for both hatchery- and natural-origin fish. The research, a whole, would benefit listed fish by adding greatly to a large number of datasets that managers use to help them survive and recover.

Under the various studies, juvenile salmon would be observed via snorkel surveys and captured using backpack electrofishing, rotary screw traps, emergence traps, trammel nets, and beach seines. In addition, juvenile salmon would be handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample of captured those fish may be anesthetized, tissue sampled and PIT-tagged prior to release. A small number of juvenile CVS Chinook and CCV steelhead (100 of each) would be sacrificed for otolith sampling and analysis. Adult salmon would be observed via snorkel surveys or spawning surveys and captured using beach seines and fish weirs. Tissues would be collected from any carcasses encountered during snorkel surveys. Juvenile green sturgeon would be captured (benthic trawls, trammel or gill nets), anesthetized, tissue sampled and tagged (PIT or acoustic). Larval green sturgeon would be captured using fyke nets. The same procedures described above would be performed on larvae captured with fyke nets (tagging would be dependent on size). Egg Mats would be used to sample green sturgeon larvae and eggs (eggs and larvae would be sacrificed). With the exception of the juvenile salmon otolith research (above), the researchers are not proposing to kill any of the fish being captured, but a small number of fish may be killed as an inadvertent result of these activities.

Permit 1440-3R

The Interagency Ecological Program (IEP) is a consortium of nine state and Federal agencies that work in partnership with non-governmental organizations to provide ecological information and scientific leadership in managing the San Francisco Bay-Delta estuary. The IEP is seeking to renew a permit that allows them to annually take adult and juvenile SacR winter-run and CVS Chinook salmon, CV and CCC steelhead, and SDPS green sturgeon in the San Francisco Bay-Delta Region, California. This permit renewal includes eleven projects.

The names and purposes of the eleven studies are: (1) The Adult Striped Bass Tagging Study—it is designed to quantify the population dynamics of Striped Bass (*Morone saxatilis*) in the San Francisco Estuary and thereby provide metrics to inform science-based resource management decisions. These metrics include relative and absolute abundance, harvest rate, mortality rate, individual growth rates, and large-scale movement/migration patterns. (2) The Fall Midwater Trawl Survey—the study is a fish monitoring survey that provides trends in abundance and distribution of pelagic fish in the upper San Francisco Estuary. (3) The adult Sturgeon Population Tagging Study is designed to quantify the population dynamics of white and green Sturgeon in the San Francisco Estuary and provide metrics to inform science-based resource management decisions. These metrics include relative and absolute abundance, harvest rates, mortality rates, and individual growth rates. (4) The Summer Tow-net Survey is a fish monitoring survey that provides trends in abundance and distribution of young pelagic fish in the upper San Francisco estuary. (5) The San Francisco Bay Study—its purpose is to determine the effects of freshwater outflow on the abundance and distribution of fish and mobile crustaceans in the San Francisco Estuary, primarily downstream of the Sacramento-San Joaquin Delta. (6) The 20-mm Survey is designed to monitor post-larval and juvenile Delta Smelt distribution and relative abundance throughout their historical spring range in the upper San Francisco estuary. (7) The Yolo Bypass Fish Monitoring Program is a monitoring effort designed to help mangers understand fish and invertebrate use in the Yolo Bypass seasonal floodplain/tidal slough habitat. (8) The Zooplankton Study—its purpose is to estimate the abundance of zooplankton taxa and thereby help managers assess trends in fish food resources from the eastern San Pablo Bay area through the eastern Sacramento-San Joaquin Delta and Suisun Marsh. The study is also intended to detect and monitor zooplankton recently introduced to the estuary and determine their effects on native species. (9) The Spring Kodiak Trawl Survey—its purpose is to determine the relative abundance and distribution of adult Delta Smelt in the San Francisco Bay area and identify the onset of spawning. (10) The Suisun Marsh Survey is designed to determine effects of the Suisun Marsh Salinity Control Gates operation (as well as other anthropogenic habitat changes) and monitor presence and abundance for juvenile striped bass, Chinook salmon, and other species of concern. (11) The Smelt Larva Survey is intended to provide near real-time distribution data for Longfin Smelt larvae in the upper San Francisco Estuary. The data generated from this study would be used to help improve the effectiveness of water operations, aquatic habitat restoration, and fish management practices. The research, as a whole, would benefit fish by adding greatly to the knowledge base that state, private, and Federal managers depend on to help them make decisions about the best ways in which resources can be allocated to help listed species recover.

Under the various projects juvenile salmon would be captured (via fyke nets, gill nets, midwater trawls, trammel nets, hoop nets, otter trawls, larval fish nets, zooplankton nets, Kodiak trawl nets, rotatory screw traps, and beach seine), handled, and released. A small subset of the juvenile fish would be captured, anesthetized, measured, weighed, tagged, tissue sampled, and released. Adult salmon would be captured (via fyke nets, midwater trawls, trammel nets, hoop nets, otter trawls, Kodiak trawl nets, and beach seines), handled, and released. A small subset of adult salmon would be captured, anesthetized, measured, weighed, tagged, tissue sampled and released. Under three of the projects (Studies 5, 7, and 9) some adipose-clipped, artificially propagated juvenile spring- and winter-run Chinook salmon would intentionally be sacrificed to collect coded wire tags (the data from which would be used for management purposes). In addition, adult green sturgeon would be captured (fyke net, trammel net, midwater trawl, otter trawl), handled, and released. A subset of juvenile and adult greens sturgeon would be captured, anesthetized, measured, weighed, tagged, tissue sampled, and released. With the exception of the directed mortality of adipose-clipped juvenile salmon (above), the researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 13675-3R

The Fishery Foundation of California is seeking to renew a permit that currently allows them to annually take juvenile SacR winter-run and CVS Chinook salmon, juvenile CV steelhead, and juvenile SDPS green sturgeon in the Sacramento River, CA. Juvenile salmon and green sturgeon would be captured (via beach seines and fyke nets), handled, and released. The purpose of this research is to evaluate salmon presence and habitat in flood plain areas. The data generated from this research would benefit listed fish by helping managers design, implement, and manage riparian habitat sites along the Sacramento River for the purpose of helping anadromous salmonids recover. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 15486-3R

West Fork Environmental is seeking to renew a previously held permit that in its new iteration would allow them to capture and handle juvenile UCR Chinook salmon, LCR Chinook salmon, UWR Chinook salmon, SnkR spr/sum Chinook, SnkR fall Chinook, PS Chinook salmon, LCR coho salmon, OC coho salmon, UCR steelhead, SnkR steelhead, MCR steelhead, LCR steelhead, UWR steelhead, and PS steelhead during the course of headwater stream surveys over wide parts of Oregon and Washington. The purpose of the research is to provide owners of industrial forest lands and state lands managers with accurate maps of where threatened and endangered salmonids are found. The work would benefit the salmon and steelhead by helping land managers plan and carry out their activities in ways that would have the smallest effect possible on the listed fish. The researchers would use backpack electrofishing equipment to capture the fish. After capture, the fish would be swiftly released without tagging or even handling more than is necessary to ensure that they have recovered from the effects of being captured. The West Fork Environmental researchers do not intend to kill any listed salmonids, but a small number may die as an unintended result of the activities.

Permit 15549-3R

The Columbia River Inter-Tribal Fish Commission (CRITFC) is seeking a five-year permit to expand on and extend work previously conducted under other research permits (Permits 1532 and 15549-2R). The research would take place in Satus, Ahtanum, Naches, and Toppenish Creeks in Washington State. The researchers wish to take juvenile MCR steelhead during the course of research designed to determine the fishes' freshwater movements and examine how those movements are affected by the area's substantially altered hydrograph. They would also collect baseline information on stock status and yearly abundance and seek to determine whether repeat spawners from a kelt reconditioning program run by the Confederated Bands and Tribes of the Yakama Nation are successfully reproducing.

The fish would be captured (via screw traps and backpack electrofishing equipment) and then be anesthetized and measured. Some would be tissue-sampled for DNA and aging purposes and some would receive passive integrated transponder (PIT) tags. The information gathered would be used to determine the fishes' movements and abundance and monitor the ongoing status of the various MCR steelhead populations in the Yakima River subbasin. The research would benefit the fish by helping managers determine the effectiveness of current recovery measures and design new ones where needed. The researchers do not plan to kill any of the fish being captured, but a few may die as an unintentional result of the research.

Permit 15611-3R

The Washington Department of Fish and Wildlife is seeking to renew a permit that allows it to take adult LCR Chinook salmon, LCR steelhead, LCR coho salmon, and CR chum salmon while operating a fish collection facility on the North Fork Toutle River in Washington State. The fish collection facility is located at river mile 47.5, approximately 1.3 miles downstream from the Mount St. Helens Sediment Retention Structure. The purpose of the project is to trap and haul salmon and steelhead around the sediment retention structure. The Washington Department of Fish and Wildlife would also collect scientific information and tag a portion of the fish to monitor migration patterns and spawning success. The activities' primary benefit would be to allow listed salmon and steelhead to spawn in historically accessible habitat upstream of the sediment retention structure. Also, researchers would collect information that would increase our understanding of the various species' spawning habits. The Washington Department of Fish and Wildlife proposes to operate the trap several days a week during the species' upstream migration. Captured fish would be transported in a tanker truck and released upstream of the sediment retention structure. The Washington Department of Fish and Wildlife does not intend to kill any fish being captured but some may die as an unintentional result of the activities.

Permit 16274-2R

The Mendocino Redwood Company (MRC) is seeking to renew a permit that currently allows them to annually take adult and juvenile CCC Chinook, CCC steelhead, SONCC coho, and CCC coho salmon in Mendocino and Northern Sonoma Counties on Mendocino Redwood Company lands. Adult fish would be observed and tissue samples would be collected from carcasses found during spawning surveys. Juvenile salmon would be observed via snorkel surveys and captured (via backpack electrofishing and screw traps), anesthetized, weighed, measured, and released. A small subset of juvenile fish would be captured, marked (dye, elastomer, or fin clip), PIT-tagged, tissue sampled, and released. The purpose of the research is to assess juvenile and adult distribution and population structure in streams on MRC's property. The data gathered in these studies would benefit listed fish by helping MRC better understand salmonid distribution, abundance, and habitat use in these areas—and thereby design and carry out their management activities in the most fish-friendly way possible. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 17077-3R

The Center for Watershed Sciences at the University of California at Davis, is seeking to renew a permit that currently allows them to annually take adult and juvenile SacR winter-run and CVS Chinook salmon, CCV steelhead and SDPS green sturgeon in the Sacramento-San Joaquin Delta and

Suisun Marsh in the Central Valley, CA. The project specifically targets splittail and other native minnow populations, however ESA-listed species may be taken as well. Juvenile fish would be captured (via otter trawling, beach seining, and electrofishing), handled and released. Adult fish would also be captured (via otter trawling, beach seining), handled, and released. The purpose of this project is to better understand how physical habitats, flow, and other factors interact to maintain assemblages of native and non-native aquatic species in the upper San Francisco estuary. This study would benefit listed fish by providing knowledge about food webs and the habitats that support them. It would improve our ability to create and restore additional habitat and help managers anticipate the effects of drought, climate change, sea level rise, increased temperatures, and changing hydrologic conditions. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 17219-3R

NMFS's Southwest Fisheries Science Center, Fisheries Ecology Division, is seeking to renew a permit that currently allows them to annually take juvenile and adult CCC, NC and S-CCC steelhead, and CCC and SONCC coho salmon in coastal streams throughout California. Juvenile fish would be captured (via screw trap, backpack electrofishing, beach seines, hook and line fishing, and hand- or dip nets), handled, and released. A subset of the captured fish would be anesthetized, sampled (collection of scales, fin clips, or stomach contents), marked or tagged (using fin clips, PIT tags, pop-off satellite tags, acoustic tags, or radio tags), and released. In limited cases, some juvenile steelhead would be captured and euthanized for otolith and contaminant analysis. Adult steelhead and coho would be observed via spawning surveys, and tissue samples would be collected from carcasses found during those surveys. Adult steelhead would be captured (at fish ladders and by hook-and-line angling), tagged, tissue sampled, and released.

The purpose of this research is to support conservation and management of ESA-listed anadromous salmonids in California by directly addressing information needs that NMFS and other agencies identify for the benefit of the listed fish. This data collected would be used to elucidate population abundance and dynamics; evaluate factors affecting growth, survival, and life-histories; assess life-stage specific habitat use and movement; inform various types of models (e.g., population, life-cycle, bioenergetics, and habitat-use models); determine genetic structure within populations; evaluate the effects how activities such as water management and habitat restoration affect populations; and develop improved sampling and monitoring methods. With the exception of a small number of juvenile steelhead that would be sacrificed for otolith and contaminant research (above), the researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 17351-2R

The Green Diamond Resource Company is seeking to renew a permit that currently allows them to annually take juvenile and adult CC Chinook, SONCC coho, and NC steelhead on Green Diamond lands in the Chetco, Smith, Lower Klamath, Mad-Redwood, and Lower Eel watersheds in Northern California. Adult salmon would be observed during spawning surveys and tissue samples would be collected from carcasses found during those surveys. A small number of adult steelhead may also be captured during screw trapping. Juvenile salmon would be captured (via backpack electrofishing, snorkel surveys, and screw trapping), handled and released. A small subset of juvenile fish would be captured, anesthetized, marked, tagged, tissue sampled and released. The purpose of this research is to determine fish presence and distribution, monitor timing and abundance of out-migrating salmon, determine population estimates of summer rearing juveniles, and determine habitat use and relative number of spawning adults. The data from this research would be used to benefit listed fish by helping Green Diamond Resource Company minimize the effects that timber harvest activities on their land may have. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 18696-5M

The Idaho Power company is seeking to modify a five-year permit that currently allows them to annually capture juvenile and adult SnkR fall Chinook salmon, SnkR spr/sum Chinook salmon, SnkR steelhead, and SnkR sockeye salmon while studying juvenile white sturgeon in and near Lower Granite Reservoir on the Snake River. The permit would be modified by combining it with a similar permit that Idaho Power holds (19846) that currently allows it to take those same species while studying bull trout in much the same area. The total action area of the two permits combined would extend from the confluence of the Snake and Grande Ronde Rivers up to the first of the Hells Canyon Complex of dams. The researchers would use small-mesh gill nets, benthic otter trawls, and hook-and-line angling to capture the fish. The gill net fishing would take place at times (October and November) and in areas (the bottom of the reservoir) that have purposefully been chosen to have the least possible impact on listed fish. When the nets are pulled to the surface, listed species would immediately be released (including by cutting the net, if necessary) and allowed to return to the reservoir. The d-ring fishing would take place in June and July, but the same restrictions (immediately releasing listed fish, etc.) would still apply. The same is true for the otter trawls that would take place solely in July and the angling that would be performed from December-March. The research targets species that are not listed, but the research would benefit listed salmonids by generating information about the habitat conditions in the Snake River and by helping managers develop conservation plans for the species that inhabit it. The researchers are not proposing to kill any of the fish they capture, but a small number of individuals may be killed as an inadvertent result of the activities.

Permit 18908-2R

The Skagit Fisheries Enhancement Group (SFEG) is seeking to renew a permit that allows them to annually take juvenile PS Chinook salmon and PS steelhead while conducting research to monitor how fish use side-channel habitat in floodplain and tributaries of the Skagit River in Washington. Fish would be captured by beach seine, handled (weighed, measured, and checked for marks or tags), and released. The purpose of the research is to assess juvenile salmonid habitat use and relative abundance in off-channel areas and thereby help improve efforts to increase access to off-channel areas and enhance rearing habitat quality in those areas.

The SFEG would use the data to identify sites in need of restoration, target enhancement efforts, confirm post-project effectiveness, and guide future projects so that ongoing work can focus on appropriate areas and help create conditions that provide high quality rearing habitat. The project also aims to educate the public on the importance of floodplain habitat restoration for juvenile salmonids, and would contribute data to other regional research projects currently evaluating the role of off-channel habitats in salmonid growth and development. The researchers are not proposing to kill any fish they capture, but a small number of juvenile salmon and steelhead may be killed as an inadvertent result of these activities.

Permit 19320-2R

NMFS's Southwest Fisheries Science Center is seeking to renew a permit that currently allows them to annually take listed salmonids while conducting research designed to: (1) Determine the inter-annual and seasonal variability in growth, feeding, and energy status among juvenile salmonids in the coastal ocean off northern and central California; (2) determine migration paths and spatial distribution among genetically distinct salmonid stocks during their early ocean residence; (3) characterize the biological and physical oceanographic features associated with juvenile salmon ocean habitat from the shore to the continental shelf break; (4) identify potential links between coastal geography, oceanographic features, and salmon distribution patterns; and (5) identify and test ecological indices for salmon survival. The renewed permit would allow the researchers to take juvenile and subadult CC Chinook, CVS Chinook, LCR Chinook, SacR winter-run Chinook, SnkR spr/sum Chinook, CCC coho, SONCC coho, CCV steelhead, CCC steelhead, and NC steelhead. This research would benefit listed fish by informing comprehensive lifecycle models that incorporate both freshwater and marine conditions and seek to account for the relationship between the two habitats. The data would also be used to identify and predict sources of salmon mortality at sea and thereby help managers develop indices of salmonid survival in the marine environment.

Listed fish would be captured primarily via surface trawling, however beach seining would be used occasionally as would hook-and-line microtrolling. Subadult salmonids (i.e*.,* fish larger than 250 mm) that survive capture would have fin tissue and scale samples taken, and then be released. During the trawling operations, any subadult salmonids that do not survive capture, and all juvenile salmonids (i.e., fish larger than 80 mm but less than 250 mm) would be lethally sampled (sacrificed) in order to collect (1) otoliths for age and growth studies; (2) coded wire tags for origin and age of hatchery fish; (3) muscle tissue for stable isotopes and/or lipid assays; (4) stomachs and contents for diet studies; and (5) other tissues including the heart, liver, intestines, pyloric caeca, and kidney for special studies upon request. For the other types of capture, some of the fish may be tissue sampled, tagged, and released (particularly adults), though some juveniles would still be lethally sampled for the reasons just described. In all cases, whenever a fish dies simply as a result of being captured, that fish would be used in place of an intentional mortality (that is, instead of a fish that would otherwise be sacrificed).

Permit 19738-2R

The Washington Department of Natural Resources (DNR) is seeking to renew a permit that allows them to annually take juvenile PS Chinook salmon and PS steelhead while conducting research in headwater streams on DNR-managed lands that drain into Puget Sound. Juvenile fish would be detected via backpack electrofishing encounters (considered a capture event for this method) and, if stunned, would be netted (dip net) and released in a low gradient stream segment or pool and allowed to recover. The purpose of this research is to determine fish presence in small streams on state-managed lands to ensure that those streams are appropriately typed, adequately protected with riparian management zones (RMZs), and adequately restored (e.g., via removal of man-made structures that limit or restrict fish passage to upstream habitat). Data generated by this proposal would benefit listed fish by informing land management decision-making (e.g. RMZ width, culvert replacement/sizing), and it would also be submitted to DNR Forest Practices division to improve the existing stream type geographic information systems database. The researchers are not proposing to kill any fish captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 19741-2R

The Yakama Nation is seeking a five-year permit to annually take juvenile, natural MCR steelhead during the course of a research project designed to assess their current abundance in the Rock Creek watershed in south central Washington. Under the permit, the researchers would employ backpack electrofishing to capture a number of juvenile MCR steelhead. Some of those fish would be tagged with PIT-tags, and some would be tissue-sampled, but most would simply be handled and released. The researchers would work primarily in five reference areas (reaches) and they would use mark/recapture techniques to study juvenile development and movement in Rock Creek. They would also conduct some boat electrofishing in the inundated pool downstream from the research area in Rock Creek—primarily to look at predator abundance. In addition, the researchers would take tissue samples from dead adults during spawning ground surveys. The purpose of the research is to assess the current distribution and relative abundance of MCR steelhead in selected portions of Rock Creek. That information would be integrated with information being collected on other ecological parameters and the researches would use that information as a whole to determine species status in the system and evaluate the effectiveness of several habitat restoration actions that have been going on there for a number of years. This research would benefit listed steelhead in that it would be used by fish managers such as the Rock Creek Subbasin Recovery Planning Group to prioritize to plan restoration, protection, and recovery actions for Rock Creek steelhead.

Permit 22482-2R

NMFS's Northwest Fisheries Science Center (NWFSC) is seeking to renew for five years a permit that currently allows them to take juvenile LCR, SnkR fall-run, UCR spring-run, and UWR Chinook salmon; CR chum salmon; LCR coho salmon; SnkR sockeye salmon; and LCR, MCR, SnkR basin, UCR, and UWR steelhead. The purpose of the study is to measure contaminant levels in resident sculpin in the lower Willamette River (Oregon) near a Superfund site with high levels of pollutants. The target species for sampling, prickly sculpin, is benthic-feeding and has a small home range, thus contaminant analysis of its tissues reflects environmental conditions at a localized area. Listed salmonids could be unintentionally captured during sampling activities. The study results would support an ongoing Natural Resource Damage Assessment, the purpose of which is to document and quantify injuries to natural resources resulting from exposure to hazardous substances. The

proposed research study would benefit listed species by improving managers' understanding of the extent of contamination in the studied habitats and informing habitat restoration activities.
The researchers propose to collect fish between river miles 2 and 11 of the Willamette River, and at appropriate reference sites nearby in the Lower Willamette River. The researchers would conduct sampling from August through October. The researchers would use vinyl-coated wire shrimp traps with 1.0 cm x 0.5 cm openings and baited with canned meat and bait scent. Any listed salmonids that are unintentionally captured would be transferred to buckets of aerated water, identified, counted, checked for fin clips, passive integrated transponder, and coded wire tags, and then swiftly released near the site of capture.

Permit 23029-2R

The NWFSC is seeking to renew a permit that allows them to annually take juvenile PS /GB Bocaccio rockfish and yelloweye rockfish, juvenile PS steelhead, and juvenile and adult PS Chinook salmon and SDPS eulachon in several river estuaries and bays of South Puget Sound, Washington. Fish would be captured via beach seine or otter trawl, handled (identified, measured, checked for marks or tags), and released. The goal of this research is to sample juvenile English sole and juvenile starry flounder and use the study results to support an ongoing Natural Resource Damage Assessment—the purpose of which is to document and quantify injuries to natural resources resulting from exposure to hazardous substances. The proposed research study would benefit listed species by improving managers' understanding of the extent of contamination in the studied habitats and helping inform habitat restoration activities.

The researchers are not targeting any ESA-listed fish for capture as part of this research, but juveniles and adults may be unintentionally captured. The work would benefit listed species by helping guide habitat restoration activities in the Puget Sound. The researchers are also not proposing to kill any ESA-listed fish, but a small number may be killed as an inadvertent result of these activities.

Permit 23649-2M

Mount Hood Environmental is seeking to modify a five-year permit that currently allows them to annually take juvenile MCR steelhead from a non-essential experimental population (NEP) in the Crooked River (Deschutes River watershed) in central Oregon. They are seeking to modify the permit by slightly increasing the take they are allotted, and the reason for this request is that new information has come to light indicating that there may be more natural steelhead present in the action area than previously believed. The researchers would use backpack electrofishing units and screw traps to capture the fish, which would then be measured, weighed, checked for marks and tags, allowed to recover, and released back to the river. A subsample of the captured fish may also be tissue-sampled for genetic assays. The purpose of the research is to establish baseline population information (presence, abundance, density, etc.) on MCR steelhead and native redband trout in the vicinity of Bowman Dam, on the Crooked River.

As noted above, the MCR steelhead that currently occupy the action area are technically part of an NEP. Taking members of this population for scientific purposes is permitted by regulation at 50 CFR 223.301 but, for the sake of analysis, they are considered part of the listed MCR steelhead DPS. The reason for that is that the NEP will expire on January 15, 2025—at which point the population will simply be considered part of the MCR steelhead DPS (although it should be noted the NEP abundance is not currently counted along with the rest of the DPS). The proposed work would benefit the species by helping managers maintain and operate Bowman Dam (and a possible new hydroelectric turbine proposed for construction there) in the most fish-friendly manner possible. The researchers do not intend to kill any of the fish being captured, but a small number may die as an unintended result of the activities.

Permit 24151

The U.S. Forest service is seeking a five-year permit that would allow them to take juvenile OC coho salmon during the course of research intended to help managers understand how juvenile coho salmon continue to thrive in a coastal lake currently containing resident populations of trophy predatory fishes (Tahkenitch Lake, Oregon). The researchers would use beach seines, minnow traps, and backpack electrofishing to capture fish in the tributaries to the lake and boat seines, beach seines, and hook-and-line fishing with barbless hooks in the lake and along the lake margins. The purpose of the research is to document coho salmon habitat shifts (seasonal and otherwise) and determine when and where predation by bass is occurring. The captured fish would be sedated and then weighed and measured. The fish would then be allowed to recover and be released back to the sites of their capture. The proposed work would benefit the species by helping managers better understand species interaction in critical coastal lake habitat and thereby help them take measures to promote coho salmon recovery. The researchers do not intend to kill any of the fish being captured, but a small number may die as an inadvertent result of the proposed activities.

Permit 24367

NMFS's Northwest Fisheries Science Center is seeking a permit that would allow them to annually take juvenile PS Chinook salmon, PS steelhead, and HC summer-run chum salmon in nearshore areas of the San Juan Islands, Whidbey Island, and in the Central and Southern Puget Sound, Washington. Fish would be captured by lampara seines, handled (weighed, measured, and checked for marks or tags), and released. A subset of juvenile PS Chinook salmon and HC chum would be intentionally lethally taken (sacrificed) for stable isotope analysis. The purposes of the research are (1) to evaluate how shoreline restoration affects subtidal use of nearshore habitats by fishes—namely salmonids and forage fish, in Puget Sound; and (2) assess the role landscape context (particularly shoreline armoring) plays in influencing these relationships. Data would be used to establish relationships between nearshore subtidal fish abundance and the degree of shoreline development, and fish habitat use data would be incorporated into the existing Beach Strategies database to further inform restoration decisions (and thereby benefit the listed fish). The researchers are proposing to kill a small subset of juvenile ESA-listed PS Chinook salmon and Hood Canal chum salmon captured, and a small number of juveniles of all species may be killed as an inadvertent result of sampling activities.

Permit 24255

The California Department of Fish and Wildlife, Fish Restoration Program, is seeking a new five-year permit that would allow them to annually take juvenile and adult SacR winter-run and CVS Chinook salmon, CCV steelhead, and SDPS green sturgeon in the Sacramento-San Joaquin Delta including Suisun Marsh and Grizzly Bay. Adult fish would be captured (via otter trawl, lampara seine), handled, and released. Juvenile fish could be captured (via beach seine, otter trawl, lampara seine, zooplankton net, backpack electrofishing) handled, and released. The purpose of this research is to monitor food web dynamics and fish populations before and after restoration and among reference, restored, and pre-restoration sites. This data would be used to assess the effectiveness of habitat restoration with regard to native fish populations and would therefore benefit listed fish by helping improve such restoration activities. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 25409

Researchers from Oregon State University are seeking a five-year permit that would allow them to document changes in fish community composition, macroinvertebrate community composition, and water quality that result from maintenance activities in agricultural channels. The project comes in response to Oregon State legislation (HB 2437 section 10), and is designed to help managers understand how cleaning and maintenance activities in agricultural ditches affect the ecosystems in those ditches. The researchers would capture fish by electrofishing, minnow traps, and seine nets in 50-meter, closed-off (with mesh block nets) channel sections. Minnow traps would be deployed the afternoon before the sampling day and be checked the following morning before the next capture method is deployed. Seine netting would be used when the site is safely accessible to capture animals that are not easily caught (too large) in minnow traps. Electrofishing would be used after both other methods are completed and would be conducted in a one-pass collecting event. Once collected, the fish would be housed in aerated containers, weighed, measured, and then released back to the sites of their capture. The research would benefit the listed species by helping mangers understand how a common agricultural practices—ditch cleaning and maintenance—affects them and the habitats upon which they depend. The researchers do not intend to kill any of the fish being captured, but some may die as an inadvertent result of the activities.

Permit 25463

The Moss Landing Marine Lab is seeking a new five-year permit that would allow them to annually take adult and juvenile SacR winter-run, CVS, and CC Chinook salmon; SONCC and CCC coho salmon; CCV, CCC, NC, S-CCC and SC steelhead; and SDPS steelhead throughout California. Fish would be captured (via electrofishing, hook-and-line angling, otter trawls, cast nets, beach seines, gill nets, and minnow traps), handled, and released. The Moss Landing Marine Laboratories' Marine

Pollution Studies Lab is a primary contributor to the California State Water Board's Surface Water Ambient Monitoring Program's Bioaccumulation Oversight Group. Results from these efforts in streams, rivers, lakes, reservoirs, bays, harbors, and coastal water bodies in California would be used to (1) measure contaminant levels in fish and shellfish over time to track temporal trends and evaluate the effectiveness of management efforts; (2) help managers evaluate contaminant spatial patterns; (3) perform Clean Water Act assessments; and (4) create and update human health advisories and assessments. Fish sampling would occur in California's anadromous and non-anadromous water bodies (streams, rivers, lakes, reservoirs, bays, harbors, and coastal) using various methods of take that would be variably employed to minimize risk to (non-targeted) listed species. Tissue samples would be analyzed for contaminants such as (but not limited to) mercury, metals, selenium, PCBs, legacy pesticides, and contaminants of emerging concern. The research would benefit listed fish by helping managers keep track of contaminants throughout the state and develop response plans accordingly. The researchers are not proposing to kill any of the listed fish being captured.

Permit 25466

Tim Salamunovich, Senior Fish Biologist for TRPA Fish Biologists, is seeing a new five –year permit that would allow him to annually take juvenile and adult steelhead in Ulatis Project Flood Control channels in (mainly) channelized portions of Ulatis, New Alamo, Sweeney, Gibson, Canyon, Horse, and McCune creeks in the Lower Sacramento River, CA. Fish would be captured via backpack electrofishing, anesthetized, measured, weighed, tissue sampled, and released. The purpose of this research is to assess fish population responses to managed flows by collecting biological data (lengths, weights, and counts) on the fish populations in order to monitor their distribution and diversity as well as their overall condition and health. The data from this research would be used to update information on the distribution, relative abundance, diversity, and health of fish in Ulatis Project stream channels and would therefore benefit the fish by helping managers operate the channels in as fish-friendly a manner as possible. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Common Elements among the Proposed Permit Actions

Research permits lay out the conditions to be followed before, during, and after the research activities are conducted. These conditions are intended to (a) manage the interaction between scientists and listed salmonids by requiring that research activities be coordinated among permit holders and between permit holders and NMFS, (b) minimize impacts on listed species, and (c) ensure that NMFS receives information about the effects the permitted activities have on the species concerned. All research permits the NMFS' WCR issues have the following conditions:

1. The permit holder must ensure that listed species are taken only at the levels, by the means, in the areas and for the purposes stated in the permit application, and according to the terms and conditions in the permit.

2. The permit holder must not intentionally kill or cause to be killed any listed species unless the permit specifically allows intentional lethal take.

3. The permit holder must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the permit holder must process listed fish first to minimize handling stress.

4. The permit holder must stop handling listed juvenile fish if the water temperature exceeds 70 degrees Fahrenheit (ºF) at the capture site. Under these conditions, listed fish may only be visually identified and counted. In addition, electrofishing is not permitted if water temperature exceeds 64ºF.

5. If the permit holder anesthetizes listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

6. The permit holder must use a sterilized needle for each individual injection when passive integrated transponder tags (PIT-tags) are inserted into listed fish.

7. If the permit holder unintentionally captures any listed adult fish while sampling for juveniles, the adult fish must be released without further handling and such take must be reported.

8. The permit holder must exercise care during spawning ground surveys to avoid disturbing listed adult salmonids when they are spawning. Researchers must avoid walking in salmon streams whenever possible, especially where listed salmonids are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when the only activity is determining fish presence.

9. The permit holder using backpack electrofishing equipment must comply with NMFS' Backpack Electrofishing Guidelines (June 2000) (NMFS 2000).

10. The permit holder must obtain approval from NMFS before changing sampling locations or research protocols.

11. The permit holder must notify NMFS as soon as possible but no later than two days after any authorized level of take is exceeded or if such an event is likely. The permit holder must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

12. The permit holder is responsible for any biological samples collected from listed species as long as they are used for research purposes. The permit holder may not transfer biological samples to anyone not listed in the application without prior written approval from NMFS.

13. The person(s) actually doing the research must carry a copy of this permit while conducting the authorized activities.

14. The permit holder must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

15. The permit holder must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

16. The permit holder may not transfer or assign this permit to any other person as defined in section 3(12) of the ESA. This permit ceases to be in effect if transferred or assigned to any other person without NMFS' authorization.

17. NMFS may amend the provisions of this permit after giving the permit holder reasonable notice of the amendment.

18. The permit holder must obtain all other Federal, state, and local permits/authorizations needed for the research activities.

19. On or before January 31st of every year, the permit holder must submit to NMFS a post-season report in the prescribed form describing the research activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the research results. The report must be submitted electronically on the APPS permit website where downloadable forms can also be found. Falsifying annual reports or permit records is a violation of this permit.

20. If the permit holder violates any permit condition, they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the permit and the requirements of the ESA or if NMFS determines that its ESA section 10(d) findings are no longer valid.

"Permit holder" means the permit holder or any employee, contractor, or agent of the permit holder. Also, NMFS may include conditions specific to the proposed research in the individual permits.

Finally, NMFS will use the annual reports to monitor the actual number of listed fish taken annually in the scientific research activities and will adjust permitted take levels if they are deemed to be excessive or if cumulative take levels rise to the point where they are detrimental to the listed species.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT (ITS)

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

This opinion constitutes formal consultation and an analysis of effects solely for the evolutionarily significant units (ESUs) and distinct population segments (DPSs) that are the subject of this opinion.[1] Herein, the NMFS determined that the proposed action of issuing 24 scientific research permits, individually or in aggregate:

- May adversely affect--CC, CVS, LCR, PS, SacR winter-run, SnkR fall-run, SnkR spr/sum-run, UCR spring-run, and UWR Chinook salmon; CR and HCS chum salmon; CCC, LCR, OC, and SONCC coho salmon; SnkR sockeye salmon; LCR, MCR, PS, SnkR, UCR, NC, CCV, CCC, S-CCC, SC, and UWR steelhead, S eulachon, SDPS green sturgeon, PS/GB bocaccio, and PS/GB yelloweye rockfish—but would not jeopardize their continued existence (see table on the first page of the document).
- Is not likely to adversely affect SR killer whales or their designated critical habitat. This conclusion is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

[1] An ESU of Pacific salmon (Waples 1991) and a DPS of steelhead (71 FR 834), rockfish, eulachon, etc., are considered to be "species" as the word is defined in section 3 of the ESA.

The critical habitat designations for many of the species considered here use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term “consequences” (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms “effects” and “consequences” interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species’ likelihood of both survival and recovery. The species status section also helps to inform the description of the species’ current “reproduction, numbers, or distribution” as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and the function of the PBFs that are essential for the conservation of the species.

Climate Change

Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014, Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007, Mote et al. 2013, Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007, Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011, Tillmann and Siemann 2011, Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999, Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC (1.8-6.7ºF) by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

In California, average summer air temperatures are expected to increase according to modeling of climate change impacts (Lindley et al. 2007). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004). Total precipitation in California may decline; critically dry years may increase (Lindley et al. 2007, Schneider 2007). Events of both extreme precipitation and intense aridity are projected for California, increasing climactic volatility throughout the state (Swain et al. 2018). Snow pack is a major contributor to stored and distributed water in the state (Diffenbaugh et al. 2015), but this important water source is becoming increasingly threatened. The Sierra Nevada snow pack is likely to decrease by as much as 70 to 90 percent by the end of this century under the highest emission scenarios modeled (Luers et al. 2006). California wildfires are expected to increase in frequency and magnitude, with 77% more area burned by 2099 under a high emission scenario model (Westerling 2018). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. The likely change in amount of rainfall in Northern and Central Coastal California streams under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline.

For the California North Coast, some models show large increases in precipitation (75 to 200 percent) while other models show decreases of 15 to 30 percent (Hayhoe et al. 2004). Many of these changes are likely to further degrade salmonid habitat by, for example, reducing stream flows during the summer and raising summer water temperatures (Williams et al. 2016). Estuaries may also experience changes detrimental to salmonids and green sturgeon. Estuarine productivity is likely to change based on alterations to freshwater flows, nutrient cycling, and sedimentation (Scavia et al. 2002). In marine environments, ecosystems and habitats important to subadult and adult green sturgeon and salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely et al. 2004, Brewer 2008, Osgood 2008, Turley 2008), which would be expected to negatively affect marine growth and survival of listed fish. The projections described above are for the mid- to late-21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Smith et al. 2007).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to affect a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of the Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. We apply the same criteria for other species as well, but in those instances, they are not referred to as "salmonid" population criteria. When any animal population or species has sufficient spatial structure, diversity, abundance, and productivity, it will generally be able to maintain its capacity to adapt to various environmental conditions and sustain itself in the natural environment.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000).

"Abundance" generally refers to the number of naturally produced adults (i.e., the progeny of naturally spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close enough to allow them to function as metapopulations (McElhany et al. 2000).

A species' status thus is a function of how well its biological requirements are being met: the greater the degree to which the requirements are fulfilled, the better the species' status. Information on the status and distribution of all the species considered here can be found in a number of documents, but the most pertinent are the status review updates and recovery plans listed in Table 2 and the specific species sections that follow. These documents and other relevant information may be found on the NOAA Fisheries West Coast Region website; the discussions they contain are summarized in the tables below. For the purposes of our later analysis, all the species considered here require functioning habitat and adequate spatial structure, abundance, productivity, and diversity to ensure their survival and recovery in the wild.

Table 2. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	SSDC 2007 NMFS 2006	NWFSC 2015	This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Recovery Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime
Puget Sound steelhead	Threatened 05/11/2007 (72 FR 26722)	NMFS 2018a (draft)	NWFSC 2015	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization
Puget Sound/ Georgia Basin DPS of	Endangered 04/28/2010 (75 FR 22276)	NMFS 2017d	NMFS 2016c	Though bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Bocaccio				Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.	• Small population dynamics
Puget Sound/ Georgia Basin DPS of Yelloweye Rockfish	Threatened 04/28/2010 (75 FR 22276)	NMFS 2017d	NMFS 2016c	Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range.	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics
Hood Canal summer-run chum salmon	Threatened 06/28/2005 (70 FR 37160)	HCCC 2005 NMFS 2007	NWFSC 2015	This ESU is made up of two independent populations in one major population group. Natural-origin spawner abundance has increased since ESA-listing and spawning abundance targets in both populations have been met in some years. Productivity was quite low at the time of the last review, though rates have increased in the last five years, and have been greater than replacement rates in the past two years for both populations. However, productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters for each population have increased and nearly meet the viability criteria.	• Reduced floodplain connectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time.	
Upper Columbia River spring-run Chinook salmon	Endangered 06/28/2005 (70 FR 37160)	UCSRB 2007	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries
Upper Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	UCSRB 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects
Middle Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2009b	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease
Snake River spring/summer-run Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2017b	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation
Snake River fall-run Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2017a	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	
Snake River basin steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2017b	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases
Snake River sockeye salmon	Endangered 06/28/2005 (70 FR 37160)	NMFS 2015a	NWFSC 2015	This single population ESU is at very high risk dues to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production In terms of natural production, the Snake River Sockeye salmon ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Lower Columbia River coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners .Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will	• Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	
Lower Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2013	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Columbia River chum salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high-risk category and considerable progress remains to be made to achieve the recovery goals.	• Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Upper Willamette River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	ODFW and NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 01/05/2006 (71 FR 834)	ODFW and NMFS 2011	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Oregon Coast coho salmon	Threatened 06/20/2011 (76 FR 35755)	NMFS 2016b	NWFSC 2015	This ESU comprises 56 populations including 21 independent and 35 dependent populations. The last status review indicated a moderate risk of extinction. Significant improvements in hatchery and harvest practices have been made for this ESU. Most recently, spatial structure conditions have improved in terms of spawner and juvenile distribution in watersheds; none of the geographic area or strata within the ESU appear to have considerably lower abundance or productivity. The ability of the ESU to survive another prolonged period of poor marine survival remains in question.	• Reduced amount and complexity of habitat including connected floodplain habitat • Degraded water quality • Blocked/impaired fish passage • Inadequate long-term habitat protection • Changes in ocean conditions
Southern Oregon/ Northern California Coast coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2014b	Williams et al. 2016	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of	• Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable	• Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects
Northern California steelhead	Threatened 6/7/2000 (65 FR 36074)	NMFS 2016a	NMFS 2016b	This DPS historically comprised 42 independent populations of winter-run steelhead (19 functionally independent and 23 potentially independent), and up to 10 independent populations (all functionally independent) of summer-run steelhead, with more than 65 dependent populations of winter-run steelhead in small coastal watersheds, and Eel river tributaries. Many populations are considered to be extant. Significant gaps in information exist for the Lower Interior and North Mountain Interior diversity strata. All winter-run populations are currently well below viability targets, with most at 5-13% of these goals. Mixed population trends arise depending on time series length; thus, there is no strong evidence to indicate conditions for winter-run populations have worsened appreciably since the last status review. Summer-run populations are of concern. While one run is near the viability target, others are very small or there is a lack of data. Overall, available information for winter- and summer-run populations do not suggest an appreciable increase or decrease in extinction risk since the last status review.	• Dams and other barriers to migration • Logging • Agriculture • Ranching • Fishery-related effects • Hatchery-related effects
California Coastal Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2016a	Williams et al. 2016	This ESU historically supported 16 Independent populations of fall-run Chinook salmon (11 Functionally Independent and five potentially Independent), six populations of spring-run Chinook salmon, and an unknown number of dependent populations. Based on the data available, eight of the 16 populations were	• Logging and road construction altering substrate composition, increasing sediment load, and reducing riparian cover • Estuarine alteration resulting in lost complexity and habitat from draining and diking

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				classified as data deficient, one population was classified as being at a Moderate/High risk of extirpation, and six populations were classified as being at a High risk of extirpation. There has been a mix in population trends, with some population escapement numbers increasing and others decreasing. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review.	• Dams and barriers diminishing downstream habitats through altered flow regimes and gravel recruitment • Climate change • Urbanization and agriculture degrading water quality from urban pollution and agricultural runoff • Gravel mining creating barriers to migration, stranding of adults, and promoting spawning in poor locations • Alien species (i.e. Sacramento Pikeminnow) • Small hatchery production without monitoring the effects of hatchery releases on wild spawners
Sacramento River winter-run Chinook salmon	Endangered 09/16/1999 (64 FR 50394)	NMFS 2014a	Williams et al. 2016	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill, Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery.	• Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures. • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • 'Natural' factors (e.g. ocean conditions)
Central Valley spring-run Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2014a	Williams et al. 2016	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill,	• Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery	• Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • 'Natural' factors (e.g. ocean conditions)
California Central Valley steelhead	Threatened 3/19/1998 (63 FR 13347)	NMFS 2014a	Williams et al. 2016	Steelhead are present throughout most of the watersheds in the Central Valley, but often in low numbers, especially in the San Joaquin River tributaries. The status of this DPS appears to have changed little since the 2011 status review stating the DPS was in danger of extinction. There is still a paucity of data on the status of wild populations. There are some encouraging signs of increased returns over the last few years. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates natural production of steelhead throughout the Central Valley remains at very low levels. Despite a positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.	• Major dams • Water diversions • Barriers • Levees and bank protection • Dredging and sediment disposal • Mining • Contaminants • Alien species • Fishery-related effects • Hatchery-related effects
Central California Coast coho salmon	Endangered 04/02/2012 (77 FR 19552) 06/28/2005	NMFS 2012	Williams et al. 2016	This ESU comprises approximately 76 populations that are mostly dependent populations. Historically, the ESU had 11 functionally independent populations and one	• Logging • Agriculture • Mining • Urbanization

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
	(70 FR 37160) Threatened 10/31/1996 (61 FR 56138)			potentially independent population organized into four stratum. Most independent populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery.	• Stream modifications - including altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas • Dams • Wetland loss • Water withdrawals (including unscreened diversions for irrigation)
Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2016a	NMFS 2016c	Both adult and juvenile abundance data are limited for this DPS. It was historically comprised of 37 independent populations (11 functionally independent and 26 potentially independent) and perhaps 30 or more dependent populations of winter-run steelhead. Most of the coastal populations are assumed to be extant with other populations (Coastal San Francisco Bay and Interior San Francisco Bay) likely at high risk of extirpation. While data availability for this DPS remains poor, there is little new evidence to suggest that the extinction risk for this DPS has changed appreciably in either direction since the last status review.	• Dams and other barriers to migration • Stream habitat degradation • Estuarine habitat degradation • Hatchery-related effects
South-Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2013b	NMFS 2016d	Currently, nearly half of this DPS reside in the Carmel River. Most other streams and rivers have small populations that can be stochastically driven to extirpation. The ability to fully assess the status of individual populations and the DPS as whole has been limited. There is little new evidence to indicate that the status of the S-CCC Steelhead DPS has changed appreciably since the last status review, though the Carmel River runs have shown a long-term decline. Threats to the DPS	• Hydrological modifications- dams, surface water diversions, groundwater extraction • Agricultural and urban development, roads, other passage barriers • Flood control, levees, channelization • Alien species • Estuarine habitat loss • Marine environment threats • Natural environmental variability • Pesticide contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				identified during initial listing have remained largely unchanged, though some fish passage barriers have been removed. Threats to this DPS are likely to exacerbate the factors affecting the continued existence of the DPS. S-CCC steelhead recovery will require reducing threats, maintaining interconnected populations across their native range, and preserving the diversity of life history strategies.	
Southern California Steelhead	Endangered 8/18/1997 (62 FR 43937)	NMFS 2013b	NMFS 2016d	This DPS includes steelhead populations along the coast of California from the Santa Maria River system to the border between the U.S. and Mexico. Within this area there are a number of very small (<10 fish) but enduring annual runs. It remains to be seen how these small runs are able to persist. Some populations in different basins are connected by relatively frequent straying. More recent genetic data show a large amount of introgression and extirpation of native fish in the southern portion of this area. There has been progress in removing fish passage barriers and in constructing fish passage in some watersheds. Recovery projects also include plant restoration and removal of non-native species. However, anthropogenic effects are overall unchanged, and impacts from climate change are expected to intensify these threats.	• Loss and degradation of estuarine habitats • Dams • Urban Development, roads • Mining, agriculture, ranching, recreation • Predation by and competition with non-native species • Disease • More frequent and extended river mouth closures • Inadequate regulatory mechanisms • Climate change induced environmental variability
Southern DPS of green sturgeon	Threatened 04/07/2006 (71 FR 17757)	NMFS 2018b	NMFS 2015b	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within	• Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	
Southern DPS of eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 2017c	Gustafson et al. 2016	The Southern DPS of eulachon includes all naturally spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, Columbia River, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries • Adverse effects related to dams and water diversions • Water quality • Shoreline construction • Over harvest • Predation

Species-specific status information is discussed in more detail below. The abundance numbers presented for each should be viewed with caution, however, as they only address one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate for species with no dam/passage counts is complicated by a host of variables, including the facts that: (1) the available data do not include all populations; (2) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (3) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (4) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (5) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

2.2.1.1 Puget Sound Chinook Salmon

Listed Hatchery Juvenile Releases – Twenty-six artificial propagation programs are part of the species and are also listed (79 FR 20802; Table 2). Juvenile listed hatchery PS Chinook salmon abundance estimates come from the annual hatchery production goals. Hatchery production varies annually due to several factors including funding, equipment failures, human error, disease, and adult spawner availability. Funding uncertainties and the inability to predict equipment failures, human error, and disease suggest that production averages from previous years is not a reliable indication of future production. For these reasons, abundance is assumed to equal production goals. The combined hatchery production goal for listed PS Chinook salmon from Table 3 is 54,843,130 adipose-fin-clipped and non-clipped juvenile Chinook salmon.

Table 3. Expected 2021 Puget Sound Chinook salmon hatchery releases (WDFW 2020).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Deschutes	Tumwater Falls	2020	Fall	3,800,000	-
Dungeness-Elwha	Dungeness	2020	Spring	-	50,000
	Elwha	2019	Fall	-	200,000
		2020	Fall	250,000	2,250,000
	Gray Wolf River	2020	Spring	-	50,000
	Hurd Creek	2020	Spring	-	50,000
	Upper Dungeness Pond	2020	Spring	-	50,000
Duwamish	Icy Creek	2019	Fall	300,000	-
	Palmer	2020	Fall	2,000,000	-
	Soos Creek	2020	Fall	3,000,000	1,200,000
Hood Canal					
	Hoodsport	2019	Fall	120,000	-
		2020	Fall	3,000,000	-
Kitsap	Bernie Gobin	2019	Spring	40,000	-
		2020	Fall	-	200,000
			Summer	4,300,000	100,000
	Garrison	2020	Fall	950,000	-
	George Adams	2020	Fall	3,375,000	425,000
	Gorst Creek	2020	Fall	1,530,000	-
	Grovers Creek	2020	Fall	450,000	-
	Hupp Springs	2020	Spring	-	500,000
	Lummi Sea Ponds	2020	Fall	950,000	-
	Minter Creek	2020	Fall	1,650,000	-
Lake Washington	Salmon in the Schools	2020	Fall	-	540
	Issaquah	2020	Fall	3,000,000	-
Nisqually	Clear Creek	2020	Fall	3,300,000	200,000
	Kalama Creek	2020	Fall	600,000	-
	Nisqually MS	2020	Fall	-	90
Nooksack	Kendall Creek	2020	Spring	1,300,000	-
	Skookum Creek	2020	Spring	-	1,000,000
Puyallup	Clarks Creek	2020	Fall	1,020,000	-
	Narrows Marina Pens	2020	Fall	30,000	-
	Voights Creek	2020	Fall	1,600,000	-
	White River	2019	Spring	-	55,000
		2020	Spring	-	340,000

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
	Wilkeson Creek	2020	Fall	400,000	-
San Juan Islands	Glenwood Springs	2020	Fall	800,000	-
Skokomish	McKernan	2020	Fall	-	100,000
Skykomish	Wallace River	2019	Summer	600,000	-
		2020	Summer	2,000,000	200,000
Stillaguamish	Brenner	2020	Fall	200,000	-
	Whitehorse Pond	2020	Summer	220,000	-
Strait of Georgia	Samish	2020	Fall	5,000,000	200,000
	Whatcom Creek	2020	Fall	500,000	-
Upper Skagit	Marblemount	2019	Spring	300,000	100,000
		2020	Spring	587,500	200,000
			Summer	200,000	-
Total Annual Release Number				**47,372,500**	**7,470,630**

Adult spawners and expected outmigration – The current abundance for PS Chinook salmon populations is 39,546 adult spawners (21,486 natural-origin and 18,060 hatchery-origin spawners; Table 4). Natural-origin spawners range from 34 (in the South Fork Nooksack River population) to 9,032 fish (in the Upper Skagit population). No populations are meeting their minimum viability abundance targets, and only three of 22 populations average greater than 20% of the minimum viability abundance target for natural-origin spawner abundance (all of which are in the Skagit River watershed).

Table 4. Five-year geometric mean abundance estimates for PS Chinook salmon natural- and hatchery-origin spawners (unpublished data, Mindy Rowse, NWFSC, July 14, 2020).

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin	Minimum Viability Abundance[a]	Expected Number of Outmigrants[b]
Strait of Georgia MPG						
NF Nooksack River	2013-2017	143	1,234	89.60%	16,000	110,136
SF Nooksack River	2015-2019	34	54	61.42%	9,100	7,080
Strait of Juan de Fuca MPG						
Elwha River	2014-2018	122	2,561	95.44%	15,100	214,650
Dungeness River	2014-2018	81	270	76.92%	4,700	28,071
Hood Canal MPG						
Skokomish River	2014-2018	202	1,335	86.85%	12,800	122,923
Mid-Hood Canal	2014-2018	149	27	15.25%	11,000	14,032
Whidbey Basin MPG						
Skykomish River	2015-2019	1,680	1,005	37.43%	17,000	214,855
Snoqualmie River	2015-2019	816	265	24.51%	17,000	86,426
NF Stillaguamish River	2015-2019	289	369	56.07%	17,000	52,648
SF Stillaguamish River	2015-2019	36	41	53.64%	15,000	6,162

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin	Minimum Viability Abundance[a]	Expected Number of Outmigrants[b]
Upper Skagit River	2014-2018	9,032	715	7.33%	17,000	779,779
Lower Skagit River	2014-2018	1,989	105	5.02%	16,000	167,531
Upper Sauk River	2014-2018	1,202	6	0.48%	3,000	96,596
Lower Sauk River	2014-2018	513	6	1.23%	5,600	41,552
Suiattle River	2014-2018	591	8	1.39%	600	47,960
Cascade River	2014-2018	186	8	4.01%	1,200	15,519
Central / South Sound MPG						
Sammamish River	2015-2019	122	716	85.46%	10,500	67,067
Cedar River	2015-2019	857	331	27.86%	11,500	95,056
Duwamish/Green River	2015-2019	1,682	4,105	70.94%	17,000	462,952
Puyallup River	2015-2019	557	1,236	68.96%	17,000	143,421
White River	2015-2019	492	2,902	85.49%	14,200	271,554
Nisqually River	2014-2018	710	761	51.73%	13,000	117,680
ESU Average		**21,486**	**18,060**	**45.67%**		**3,163,652**

[a] Ford 2011

[b] Expected number of outmigrants=Total spawners*40% proportion of females*2,000 eggs per female*10% survival rate from egg to outmigrant

Juvenile PS Chinook salmon abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Fecundity estimates for the ESU range from 2,000 to 5,500 eggs per female, and the proportion of female spawners in most populations is approximately 40% of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 15,818 females), the ESU is estimated to produce approximately 31.6 million eggs annually. Smolt trap studies have researched egg to migrant juvenile Chinook salmon survival rates in the following Puget Sound tributaries: Skagit River, North Fork Stillaguamish River, South Fork Stillaguamish River, Bear Creek, Cedar River, and Green River (Beamer et al. 2000; Seiler et al. 2002, 2004, 2005; Volkhardt et al. 2005; Griffith et al. 2004). The average survival rate in these studies was 10%, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10%, the ESU should produce roughly 3.16 million natural-origin outmigrants annually.

2.2.1.2 Puget Sound Steelhead

Listed Hatchery Juvenile Releases – Six artificial propagation programs were listed as part of the DPS (79 FR 20802; Table 5). For 2021, 222,500 hatchery steelhead are expected to be released throughout the range of the PS steelhead DPS (WDFW 2020).

Table 5. Expected 2021 Puget Sound steelhead listed hatchery releases (WDFW 2020).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Dungeness/Elwha	Dungeness	2020	Winter	10,000	-
	Hurd Creek	2021	Winter	-	34,500
Duwamish/Green	Flaming Geyser	2020	Winter	-	15,000
	Icy Creek	2020	Summer	50,000	-
			Winter	-	28,000
	Soos Creek	2020	Summer	50,000	-
Puyallup	White River	2020	Winter	-	35,000
Total Annual Release Number				**110,000**	**112,500**

Adult spawners and expected outmigration – The current abundance for the PS steelhead DPS is 19,456 adult spawners (natural-origin and hatchery-production combined). Juvenile PS steelhead abundance estimates is calculated from the escapement data (Table 6). For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (9,728 females), 34.05 million eggs are expected to be produced annually. With an estimated survival rate of 6.5% (Ward and Slaney 1993), the DPS should produce roughly 2.21 million natural-origin outmigrants annually.

Table 6. Five-year geometric mean abundance estimates for PS steelhead spawner escapements (natural-origin and hatchery-production combined) (data accessed on June 30, 2020 from WDFW Steelhead - General Information Page).

Demographically Independent Populations	Years	Spawners	Expected Number of Outmigrants[a]
Central and South Puget Sound MPG			
Cedar River	2015-2019	3	340
Green River	2015-2019	1,262	143,532
Nisqually River	2015-2019	1,368	155,563
N. Lake WA/Lake Sammamish	-	0	-
Puyallup/Carbon River	2015-2019	953	108,425
White River	2014-2018	649	73,791
Hood Canal and Strait of Juan de Fuca MPG			
Dungeness River	2009-2014	26	-
East Hood Canal Tribs.	2014-2018	75	8,510
Elwha River	2014-2018	1,232	140,193
Sequim/Discovery Bay Tribs.	2013-2017	22	2,474
Skokomish River	2014-2018	877	99,702
South Hood Canal Tribs.	2014-2018	64	7,330
Strait of Juan de Fuca Tribs.	2014-2018	107	12,191
West Hood Canal Tribs.	2014-2018	142	16,206
North Cascades MPG			
Nooksack River	2014-2018	1,822	207,205
Pilchuck River	2015-2019	634	72,096

Demographically Independent Populations	Years	Spawners	Expected Number of Outmigrants[a]
Samish River/ Bellingham Bay Tribs.	2012-2016	977	111,167
Skagit River	2014-2018	7,527	856,175
Snohomish/Skykomish Rivers	2015-2019	690	78,532
Snoqualmie River	2015-2019	500	56,863
Stillaguamish River	2015-2019	487	55,346
Tolt River	2015-2019	40	4,498
TOTAL		**19,456**	**2,210,140**

[a] Expected number of outmigrants=Total spawners*50% proportion of females*3,500 eggs per female*6.5% survival rate from egg to outmigrant.

2.2.1.3 Puget Sound/Georgia Basin Bocaccio

Bocaccio in the Puget Sound/Georgia Basin were historically most common within the South Sound and Main Basin (Drake et al. 2010). Though bocaccio were never a predominant segment of the multi-species rockfish abundance within the Puget Sound/Georgia Basin (Drake et al. 2010), their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Bocaccio abundance may be very low in large segments of the Puget Sound/Georgia Basin. Productivity is driven by high fecundity and episodic recruitment events, largely correlated with environmental conditions. Thus, bocaccio populations do not follow consistent growth trajectories and sporadic recruitment drives population structure (Drake et al. 2010).

Natural annual mortality is approximately 8 percent (Palsson et. al 2009). Tolimieri and Levin (2005) found that the bocaccio population growth rate is around 1.01, indicating a very low intrinsic growth rate for this species. Demographically, this species demonstrates some of the highest recruitment variability among rockfish species, with many years of failed recruitment being the norm (Tolimieri and Levin 2005). Given their severely reduced abundance, Allee effects may be particularly acute for bocaccio, even considering the propensity of some individuals to move long distances and potentially find mates.

In Canada, the median estimate of bocaccio biomass is 3.5 percent of its unfished stock size (though this included Canadian waters outside of the DPS's area) (Stanley et al. 2012). There are no analogous biomass estimates in the U.S. portion of the bocaccio DPS. However, the Remotely Operated Vehicle (ROV) survey of the San Juan Islands in 2008 estimated a population of 4,606±4,606 (based on four fish observed along a single transect), but no estimate could be obtained in the 2010 ROV survey because this species was not encountered. A single bocaccio encountered in the 2015 ROV survey produced a statistically invalid population estimate for that portion of the DPS lying south of the entrance to Admiralty Inlet and east of Deception Pass. Several bocaccio have been caught in genetic surveys and by recreational anglers in Puget Sound proper in the past several years.

In summary, though abundance and productivity data for yelloweye rockfish and bocaccio is relatively imprecise, both abundance and productivity have been reduced largely by fishery removals within the range of each Puget Sound/Georgia Basin DPSs.

2.2.1.4 Puget Sound/Georgia Basin Yelloweye Rockfish

Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin. The San Juan Basin has the most suitable rocky benthic habitat (Palsson et al. 2009) and historically was the area of greatest numbers of angler catches (Moulton and Miller 1987; Olander 1991).

Productivity for yelloweye rockfish is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from 2 to 4.6 percent (Yamanaka and Kronlund 1997; Wallace 2007). Productivity may also be particularly impacted by Allee effects, which occur as adults are removed by fishing and the density and proximity of mature fish decreases. Adult yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002) and it is unknown the extent they may move to find suitable mates.

In Canada, yelloweye rockfish biomass is estimated to be 12 percent of the unfished stock size on the inside waters of Vancouver Island (DFO 2011). There are no analogous biomass estimates in the U.S. portion of the yelloweye rockfish DPS. However, WDFW has generated several population estimates of yelloweye rockfish in recent years. ROV surveys in the San Juan Island region in 2008 (focused on rocky substrate) and 2010 (across all habitat types) estimated a population of 47,407±11,761 and 114,494±31,036 individuals, respectively. A 2015 ROV survey of that portion of the DPSs south of the entrance to Admiralty Inlet encountered 35 yelloweye rockfish, producing a preliminary population estimate of 66,998±7,370 individuals (final video review is still under way) (WDFW 2017).

2.2.1.5 Hood Canal Summer-run Chum Salmon

Listed Hatchery Juvenile Releases – Four artificial propagation programs were listed as part of the ESU (79 FR 20802); however, only one program is currently active. The combined hatchery production goal for listed HCS chum salmon from Table 7 is 150,000 unmarked juvenile chum salmon.

Table 7. Expected 2019 Hood Canal summer-run juvenile chum salmon hatchery releases (WDFW 2018).

Subbasin	Artificial propagation program	Brood year	Run Timing	Clipped Adipose Fin	Intact Adipose Fin
Hood Canal	LLTK – Lilliwaup	2018	Summer	-	150,000
Total Annual Release Number				**-**	**150,000**

Adult spawners and expected outmigration – The current average run size of 40,526 adult spawners (38,697 natural-origin and 1,829 hatchery-origin spawners; Table 8) is largely the result of aggressive reintroduction and supplementation programs throughout the ESU. In the Strait of Juan de Fuca population, the annual natural-origin spawners returns for Jimmycomelately Creek dipped to a single fish in 1999 and again in 2002 (unpublished data, Mindy Rowse, NWFSC, Feb 2, 2017). From 2013 to 2017, Jimmycomelately Creek averaged 2,634 natural-origin spawners. Salmon and

Snow Creeks have improved substantially. Natural-origin spawner abundance was 130 fish in 1999, whereas the average for Salmon and Snow creeks were 2,521 and 332, respectively, for the 2013-2017 period.

Table 8. Abundance of natural-origin and hatchery-origin HCS chum salmon spawners in escapements 2013-2017 (unpublished data, Mindy Rowse, NWFSC, Apr 12, 2019).

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[c]
Strait of Juan de Fuca Population				
Jimmycomelately Creek	2,634	406	13.35%	444,570
Salmon Creek	2,521	0	0.00%	368,728
Snow Creek	332	0	0.00%	48,511
Chimacum Creek	1,611	0	0.00%	235,549
Population Average[d]	7,098	406	5.41%	1,097,359
Hood Canal Population				
Big Quilcene River	11,472	0	0.00%	1,677,808
Little Quilcene River	900	0	0.00%	131,586
Big Beef Creek	34	0	0.00%	5,024
Dosewallips River	4,329	2	0.05%	633,424
Duckabush River	6,151	2	0.04%	899,993
Hamma Hamma River	3,718	0	0.00%	543,729
Anderson Creek	3	0	0.00%	374
Dewatto River	159	0	0.00%	23,298
Lilliwaup Creek	784	960	55.03%	255,106
Skokomish River	489	395	44.68%	129,222
Tahuya River	1,869	64	3.33%	282,815
Union River	1,690	0	0.00%	247,125
Population Average[d]	31,599	1,423	4.31%	4,829,506
ESU Average	**38,697**	**1,829**	**4.51%**	**5,926,865**

[a] Five-year geometric mean of post fishery natural-origin spawners (2013-2017).
[b] Five-year geometric mean of post fishery hatchery-origin spawners (2013-2017).
[c] Expected number of outmigrants=Total spawners*45% proportion of females*2,500 eggs per female*13% survival rate from egg to outmigrant.
[d] Averages are calculated as the geometric mean of the annual totals (2013-2017).

Escapement data, the percentage of females in the population, and fecundity can estimate juvenile HCS chum salmon abundance. ESU fecundity estimates average 2,500 eggs per female, and the proportion of female spawners is approximately 45% of escapement in most populations (WDFW/PNPTT 2000). By applying fecundity estimates to the expected escapement of females (both natural-origin and hatchery-origin spawners – 18,237 females), the ESU is estimated to produce approximately 45.6 million eggs annually. For HCS chum salmon, freshwater mortality rates are high with no more than 13% of the eggs expected to survive to the juvenile migrant stage (Quinn 2005). With an estimated survival rate of 13%, the ESU should produce roughly 5.93 million natural-origin outmigrants annually.

2.2.1.6 Upper Columbia River Spring-run Chinook Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – This ESU includes Chinook salmon from six artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries were 621,759 LHAC and 368,642 LHIA UCR spring-run Chinook salmon smolts annually (Zabel 2014, 2015, 2017a, 2017b, 2018). To estimate abundance of natural juvenile UCR spring-run Chinook salmon, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile UCR spring-run Chinook salmon, an estimated average of 468,820 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2018). The most recent five-year geometric means (2014-2018) for UCR spring-run Chinook salmon are 2,872 natural-origin, 6,226 LHAC, and 3,364 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Table 9. Recent Five-Year Geometric Means for the Estimated Juvenile Outmigrations and Adult returns of UCR Chinook (Zabel 2015, 2017a, 2017b, 2018, 2020, AMIP 2019).

Life Stage	Origin	Outmigration/Return
Juvenile	Natural	468,820
Juvenile	LHAC	621,759
Juvenile	LHIA	368,642
Adult	Natural	2,872
Adult	LHAC	6,226
Adult	LHIA	3,364

2.2.1.7 Upper Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Six artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 687,567 LHAC and 138,601 LHIA UCR steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile UCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile UCR steelhead, an estimated average of 199,380 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2019). The five-year geometric means (2015-2019) for UCR steelhead are 1,931 natural-origin; 5,309 LHAC, and 1,163 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

2.2.1.8 Middle Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Seven artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 444,973 LHAC and 110,469 LHIA MCR steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile MCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile MCR steelhead, an estimated average of 407,697 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2019). The five-year geometric means (2015-2019) for MCR steelhead are 5,052 natural-origin; 448 LHAC, and 112 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

2.2.1.9 Snake River Spring/Summer-run Chinook Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – 11 artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2014-2018, the geometric means for the releases from these hatcheries are 4,760,250 LHAC and 868,679 LHIA spr/sum Chinook annually (Zabel 2014, 2015, 2017a, 2017b, 2018). To estimate abundance of natural juvenile spr/sum Chinook, we calculate the geometric means for outmigrating smolts over the past five years for which we have data (2014-2018) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018). For natural-origin juvenile spr/sum Chinook, an estimated average of 1,296,641 juveniles outmigrated over the five most recent years for which we have data.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2018). The five-year geometric means (2014-2018) for SnkR spr/sum-run Chinook salmon are 12,798 natural-origin, 2,387 LHAC, and 421 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).2.2.1.11 Snake River Fall-run Chinook salmon

2.2.1.10 Snake River fall-run Chinook Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – four artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 2,483,713 LHAC and 2,862,418 LHIA SnkR fall Chinook annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile SnkR fall Chinook, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile SnkR fall Chinook, an estimated average of 692,819 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2020). The five-year geometric means (2015-2019) for SnkR fall Chinook salmon are 10,337 natural-origin; 12,508 LHAC, and 13,551 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Table 10. Recent Five-Year Geometric Means for the Estimated Juvenile Outmigrations and Adult returns of SnkR Fall-run Chinook (Zabel 2015, 2017a, 2017b, 2018, 2020, AMIP 2019).

Life Stage	Origin	Outmigration/Return
Juvenile	Natural	692,819
Juvenile	LHAC	2,483,713
Juvenile	LHIA	2,862,418
Adult	Natural	10,337
Adult	LHAC	12,508
Adult	LHIA	13,551

2.2.1.11 Snake River Basin Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – six artificial propagation programs were listed as part of the DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 3,300,152 LHAC and 705,490 LHIA SnkR basin steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of natural juvenile SnkR basin steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile SnkR basin steelhead, an estimated average of 798,341 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2018). The five-year geometric means (2014-2018) for SnkR basin steelhead are 10, 547 natural-origin, 79,510 LHAC, and 16,137 LHIA adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

2.2.1.12 Snake River Sockeye Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – One artificial propagation program was listed as part of this ESU – Redfish Lake Captive Broodstock Program (79 FR 20802). From 2015-2019, the geometric mean for the releases from this hatchery program was 242,610 LHAC fish (Zabel 2015, 2017a, 2017b, 2018, 2020). There were no LHIA SnkR sockeye because all the fish from the program are clipped. To estimate abundance of natural juvenile SnkR sockeye, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For natural-origin juvenile SnkR sockeye, an estimated average of 19,181 juveniles outmigrated over the last five years.

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2018). The five-year geometric means (2014-2018) for SnkR sockeye salmon are 546 natural-origin and 4,004 LHAC adults. The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery outmigrants found in the NWFSC outmigration estimate memos (above).

2.2.1.13 Lower Columbia River Chinook Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – This ESU includes fifteen ESA-listed artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 31,353,395 LHAC and 962,458 LHIA LCR Chinook salmon smolts (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile LCR Chinook salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018). For juvenile natural-origin LCR Chinook salmon, an estimated average of 11,745,027 juvenile salmon outmigrated over the last five years.

Adult Abundance – The average abundance for LCR Chinook salmon populations is 68,061 adult spawners (29,469 natural-origin and 38,594 hatchery-origin spawners; Table 11).

Table 11. Average abundance estimates for LCR Chinook salmon natural- and hatchery-origin spawners (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page).

Coastal Stratum – Fall run				
Youngs Bay	2012-2014	233	5,606	96.01%
Grays/Chinook	2010-2014	100	357	78.12%
Big Creek	2012-2014	32	1,510	97.92%
Elochoman/Skamokowa	2010-2014	116	580	83.33%
Clatskanie	2012-2014	98	3,193	97.02%
Mill/Abernathy/Germany	2010-2014	92	805	89.74%
Cascade Stratum – Fall run				
Lower Cowlitz	2010-2013	723	196	21.33%
Upper Cowlitz	2010-2013	2,873	961	25.07%
Toutle	2010-2014	3,305	5,400	62.03%
Coweeman	2010-2014	385	963	71.44%
Kalama	2010-2014	803	8,892	91.72%
Lewis	2010-2014	2,178	943	30.21%
Washougal	2010-2014	192	116	37.66%
Clackamas	2012-2014	1,272	2,955	69.91%
Sandy	2012-2014	1,207	320	20.96%
Columbia Gorge Stratum – Fall run				
Lower Gorge	2003-2007	146	-	-
Upper Gorge	2010-2012	200	327	62.05%
White Salmon	2010-2014	829	246	22.88%
Cascade Stratum – Late fall run				
North Fork Lewis	2010-2014	12,330	0	0.00%
Cascade Stratum – Spring run				
Upper Cowlitz/Cispus	2010-2014	279	3,614	92.83%
Kalama	2011-2014	115	-	-
North Fork Lewis	2010-2014	217	0	0.00%
Sandy	2010-2014	1,731	1,470	45.92%
Gorge Stratum – Spring run				
White Salmon	2013-2014	13	140	91.50%

2.2.1.14 Lower Columbia River Coho Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – The LCR coho salmon ESU includes 21 artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 7,287,647 LHAC and 249,784 LHIA LCR coho salmon smolts annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile LCR coho salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin LCR coho salmon, an estimated average of 661,468 juvenile salmon outmigrated over the last five years.

Adult Abundance – The average abundance for LCR coho salmon populations is 38,657 adult spawners (29,866 natural-origin and 8,791 hatchery-origin spawners; Table 12).

Table 12. Average abundance estimates for LCR coho salmon natural- and hatchery-origin spawners (Lewis et al. 2009, 2010, 2011, 2012, 2014; Sounhein et al. 2014, 2015, 2016, 2017, 2018; WDFW Conservation - Coho salmon webpage).

Population Name	Years	Natural-origin Spawners	Hatchery-origin Spawners	% Hatchery Origin
Coastal Stratum				
Grays/Chinook	2013-2017	284	429	60.14%
Elochoman/Skamokowa	2013-2017	587	306	34.22%
Mill/Abernathy/Germany	2013-2017	733	73	9.05%
Youngs Bay	2008-2012	79	121	60.61%
Big Creek	2008-2012	349	171	32.86%
Clatskanie	2013-2017	614	81	11.71%
Scappoose	2013-2017	811	3	0.39%
Cascade Stratum				
Lower Cowlitz	2013-2017	4,502	668	12.92%
Upper Cowlitz/Cispus	2013-2017	5,245	478	8.36%
Titlton	2013-2017	3,039	3,193	51.24%
SF Toutle	2013-2017	1,711	472	21.63%
NF Toutle	2013-2017	1,039	789	43.15%
Coweeman	2013-2017	2,032	309	13.21%
Kalama	2013-2017	33	172	83.96%
NF Lewis	2013-2017	520	151	22.55%
EF Lewis	2013-2017	835	283	25.29%
Salmon Creek	2013-2017	1,465	44	2.91%
Washougal	2013-2017	219	416	65.52%
Clackamas	2013-2017	3,762	319	7.82%
Sandy	2013-2017	1,315	25	1.87%
Gorge Stratum				
Lower Gorge	2012-2016	576	142	19.75%
Upper Gorge/White Salmon	2013-2017	47	13	21.12%
Hood	2012-2016	68	133	66.15%
ESU Average		**29,866**	**8,791**	**22.74%**

2.2.1.15 Lower Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Seven artificial propagation programs were listed as part of this DPS (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 1,197,156 LHAC and 9,138 LHIA LCR steelhead annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile natural LCR steelhead, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin LCR steelhead, an estimated average of 352,146 juvenile steelhead outmigrated over the last five years.

Adult Abundance – The average abundance for LCR steelhead salmon populations is 35,217 adult spawners (12,920 natural-origin and 22,297 hatchery-origin spawners; Table 13).

Table 13. Average abundance estimates for LCR steelhead natural- and hatchery-origin spawners (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page).

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Cascade Stratum – Winter run				
Lower Cowlitz	2009	0	4,559	100.00%
Upper Cowlitz/Cispus	2010-2014	438	51	10.43%
Tilton	2010-2013	279	0	0.00%
South Fork Toutle	2010-2014	501	7	1.38%
North Fork Toutle	2010-2014	387	121	23.82%
Coweeman	2010-2014	296	166	35.93%
Kalama	2011-2015	475	455	48.92%
North Fork Lewis	2007-2011	129	2,126	94.28%
East Fork Lewis	2010-2014	364	0	0.00%
Washougal	2010-2014	167	195	53.87%
Clackamas	2014-2015	3,607	1,876	34.21%
Sandy	2013-2015	3,810	284	6.94%
Cascade Stratum – Summer run				
Kalama	2011-2015	127	499	79.71%
North Fork Lewis	2009	0	10,508	100.00%
East Fork Lewis	2011-2015	760	168	18.10%
Washougal	2012-2015	102	621	85.89%
Gorge Stratum – Winter run				
Upper Gorge	2010-2014	36	0	0.00%
Hood	2003-2007	438	380	46.45%
Gorge Stratum – Summer run				
Wind	2010-2014	763	42	5.22%
Hood	2003-2007	241	239	49.79%
DPS Average		**12,920**	**22,297**	**63.31%**

2.2.1.16 Columbia River Chum Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Two artificial propagation programs were listed as part of the ESU (79 FR 20802). All the fish produced in these hatcheries have intact adipose fins. From 2015-2019, the geometric means for the releases from these hatcheries are 01,503 LHIA CR chum salmon smolts (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile CR chum salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin CR chum salmon is juvenile salmon, an estimated average of 6,626,218 outmigrated over the last five years.

Adult Abundance – The average abundance for CR chum salmon populations is 11,070 adult spawners (10,644 natural-origin and 426 hatchery-origin spawners; Table 14).

Table 14. Average abundance estimates for CR chum salmon natural- and hatchery-origin spawners (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page).

Population Name	Years	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin
Coastal Ecological Zone				
Grays/Chinook	2010-2014	6,604	421	5.99%
Elochoman/Skamania	2002-2004	122	-	-
Mill/Abernathy/Germany	2002-2004	40	-	-
Cascade Ecological Zone				
Lewis River	2011-2013	36	-	-
Washougal River	2010-2014	2,440	-	-
Columbia Gorge Ecological Zone				
Lower Gorge tributaries	2010-2014	1,600	5	0.31%
Upper Gorge tributaries	2010-2014	106	-	-
ESU Average		**10,644**	**426**	**3.85%**

2.2.1.17 Upper Willamette River Chinook Salmon

Listed Hatchery Juvenile Releases – This ESU includes spring-run Chinook salmon from six artificial propagation programs (79 FR 20802). From 2015-2019, the geometric means for the releases from these hatcheries are 4,709,045 LHAC and 157 LHIA UWR Chinook salmon smolts annually (Zabel 2015, 2017a, 2017b, 2018, 2020). To estimate abundance of juvenile UWR Chinook salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018). For juvenile natural-origin UWR Chinook salmon, and estimated average of 1,211,863 juvenile salmon outmigrated over the last five years.

Adult spawners and expected outmigration – The average (2013-2017) abundance of UWR Chinook salmon is 41,679 adult spawners (10,203 natural-origin and 31,476 hatchery-origin spawners; Table 15).

Table 15. Adult UWR spring-run Chinook salmon abundance (ODFW and WDFW 2014, 2015, 2016, 2017, 2018).

2013	11,182	24,532	35,714
2014	7,758	29,523	37,281
2015	11,973	49,561	61,534
2016	10,588	27,679	38,267
2017	10,054	31,096	41,150

[a] Sum of Natural + Hatchery escapement to Willamette Falls fish ladder and the Clackamas River
[b] Five-year geometric mean of post-fishery spawners (2013-2017)

2.2.1.18 Upper Willamette River Steelhead

Listed Hatchery Juvenile Releases – There are no listed hatchery programs for this DPS. To estimate abundance of natural juvenile UWR steelhead, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020). For juvenile natural-origin UWR steelhead, an estimated average of 140,396 juveniles outmigrated over the last five years.

Adult Abundance – The average abundance for UWR steelhead populations is 2,912 adult natural-origin spawners (Table 16).

Table 16. Five-year geometric mean for adult UWR winter-run steelhead abundance from 2013/2014 through 2017/2018 (ODFW - Lower Willamette Fisheries and Willamette Falls Fish Counts).

2013-2014	5,349
2014-2015	4,508
2015-2016	5,778
2016-2017	822
2017-2018	1,829

2.2.1.19 Oregon Coast Coho Salmon

Listed Hatchery Juvenile Releases – The OC coho salmon ESU includes one artificial propagation programs – Cow Creek Hatchery Program (Oregon Department of Fish and Wildlife Stock #18) (79 FR 20802). The hatchery production goal is 60,000 adipose-fin-clipped yearling OC coho salmon (ODFW 2017).

Adult spawners and expected outmigration – The average abundance for OC coho salmon populations is 94,879 adult spawners (94,320 natural-origin and 559 hatchery-origin spawners; Table 17).

Table 17. Average abundance estimates for OC coho salmon natural- and hatchery-origin spawners (Sounhein et al. 2014, 2015, 2016, 2017, 2018).

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[b]
North Coast Stratum				
Necanicum River	1,139	5	0.42%	80,063
Nehalem River	7,073	11	0.16%	495,889
Tillamook Bay	4,771	19	0.39%	335,290
Nestucca River	2,320	2	0.09%	162,547
North Coast Dependents	602	3	0.49%	42,350
Mid-Coast Stratum				
Salmon River	924	9	0.98%	65,352
Siletz River	5,534	2	0.04%	387,545
Yaquina River	4,585	2	0.05%	321,141
Beaver Creek	1,634	1	0.09%	114,493
Alsea River	8,627	0	0.00%	603,904
Siuslaw River	12,994	0	0.00%	909,584
Mid Coast Dependents	1,190	7	0.56%	83,747
Lakes Stratum				
Siltcoos Lake	2,362	0	0.00%	165,333
Tahkenitch Lake	1,356	2	0.13%	95,077
Tenmile Lake	2,909	0	0.00%	203,660
Umpqua Stratum				
Lower Umpqua River	8,755	2	0.02%	612,987
Middle Umpqua River	3,080	0	0.00%	215,578
North Umpqua River	2,320	191	7.59%	175,760
South Umpqua River	3,683	299	7.52%	278,743
Mid-South Coast Stratum				
Coos River	6,320	0	0.00%	442,407
Coquille River	10,781	3	0.03%	754,870
Floras Creek	1,154	0	0.00%	80,785
Sixes River	200	0	0.00%	14,029
Mid-South Coast Dependents	5	1	16.36%	428
ESU Average	**94,320**	**559**	**0.59%**	**6,641,564**

[a] Five-year geometric mean of post-fishery spawners (2013-2017).

[b] Expected number of outmigrants=Total spawners*50% proportion of females*2,000 eggs per female*7% survival rate from egg to outmigrant.

While we currently lack data on how many natural juvenile coho salmon this ESU produces, it is possible to make rough estimates of juvenile abundance from adult return data. The five-year geometric mean from 2013 through 2017 is estimated at 94,879 spawners (Table 17). Sandercock (1991) published fecundity estimates for several coho salmon stocks; average fecundity ranged from 1,983 to 5,000 eggs per female. By applying a very conservative value of 2,000 eggs per female to an estimated 47,440 females returning (roughly half of 94,879) to this ESU, one may expect approximately 94.88 million eggs to be produced annually. Nickelson (1998) found survival of coho salmon from egg to parr in Oregon coastal streams to be around 7%. Thus, we can estimate that roughly the Oregon Coast ESU produces 6.64 million juvenile coho salmon annually.

2.2.1.20 Southern Oregon/Northern California Coast Coho Salmon

Listed Hatchery Juvenile Releases – Three artificial propagation programs were listed as part of the ESU (79 FR 20802). Hatchery releases from these hatcheries average 200,000 LHAC and 575,000 LHIA SONCC coho salmon juveniles annually (ODFW 2011, CHSRG 2012).

Adult spawners and expected outmigration – The average abundance for SONCC coho salmon populations is 19,990 adult spawners (9,065 natural-origin and 10,934 hatchery-origin spawners; Table 18).

Table 18. Estimates of the natural-origin and hatchery-produced adult coho salmon returning to the Rogue, Trinity, and Klamath rivers (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project, Kier et al 2015, CDFW 2012).

YEAR	Rogue River		Trinity River		Klamath River		
	Hatchery	Natural	Hatchery	Natural	Shasta River[a]	Scott River[a]	Salmon River
2008	158	414	3,851	944	30	62	
2009	518	2,566	2,439	542	9	81	
2010	753	3,073	2,863	658	44	927	
2011	1,156	3,917	9,009	1,178	62	355	
2012	1,423	5,440	8,662	1,761		201	
2013	1,999	11,210	11,177	4,097			
2014	829	2,409	8,712	917			
Average [b]	**1,417**	**6,353**	**9,517**	**2,258**	**38**	**357**	**50 [c]**

[a] Hatchery proportion unknown, but assumed to be low.
[b] 3-year average of most recent years of data.
[c] Annual returns of adults are likely less than 50 per year (NMFS 2014b).

While we currently lack data on naturally-produced juvenile coho salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. Quinn (2005) published estimates for salmonids in which average fecundity for coho salmon is 2,878 eggs per female. By applying the average fecundity of 2,878 eggs per female to the estimated 9,995 females returning (half of the average total number of spawners), approximately 28.8 million eggs may be expected to be produced annually. Nickelson (1998) found survival of coho salmon from egg to parr in Oregon coastal streams to be around 7 percent. Thus, we approximate that this ESU produces about 2,013,593 juvenile SONCC coho salmon outmigrants annually.

2.2.1.21 Northern California Steelhead

The DPS includes all naturally spawned populations of steelhead in rivers and streams from Redwood Creek (Humboldt County) south to the Gualala River (Mendocino County). Extant summer-run populations are found in Redwood Creek, Mad River, Eel River (Middle Fork), and

Mattole River. The Northern California Coast steelhead DPS begins at the Russian River and extends south to Aptos Creek. This leaves several *O. mykiss* populations in small watersheds between the Gualala and Russian rivers that are not currently assigned to either DPS. The NC steelhead DPS is comprised of both winter- and summer-run steelhead populations (Table 19).

Table 19. Historical NC Steelhead Independent Populations (NMFS 2011).

Population Groups	Run	Populations
Northern Coastal	Summer	Mad River (lower), Mattole River, Redwood Creek (lower), South Fork Eel River
	Winter	Humboldt Bay, Little River, Mattole River, Redwood Creek (lower), South Fork Eel River
Lower Interior	Winter	Woodman Creek, Chamise Creek, Tomki Creek, Outlet Creek
Northern Mountain Interior	Summer	Mad River (upper), Redwood Creek (upper), Upper Mid-mainstem Van Duzen Creek
	Winter	Larabee Creek, Middle Fork Eel River, North Fork Eel River, Redwood Creek (upper), Van Duzen Creek
North-Central Coastal	Winter	Big River, Caspar Creek, Noyo River, Ten Mile River, Usal Creek, Wages Creek
Central Coastal	Winter	Garcia River, Gualala River, Navarro River

*Abundance and Productivity***.** Short- and long-term trends have been calculated for a few rivers in this DPS (Table 20). Abundance trends for Little River have been significantly negative with the annual abundance having not been above 20 during the past decade (Gallagher and Wright 2009, 2011, and 2012, Williams et al. 2011, Gallagher et al. 2013). In Redwood Creek, annual dive surveys have occurred since 1981. Williams et al. (2011) stated at the time the 16-year trend was positive ($p = 0.029$); however, the critically low abundance overshadowed the trend. For the Upper Eel River, abundance data are gathered from the Van Arsdale Fish Station. The short-term trend for the upper Eel River is positive, but there were no significant trends for the other three rivers: Freshwater Creek, South Fork (SF) Noyo River, and Gualala River (Williams et al. 2011). The most recent status review found that for many winter-run populations, while long-term trends have been negative run sizes of natural-origin steelhead have stabilized or are increasing. Summer-run populations continue to be of significant concern, and overall available data do not suggest an appreciable change in extinction risk since the 2011 status review despite the fact that most populations remain below viability targets (NMFS 2016e).

Table 20. Short- and Long-term Trends in NC Steelhead Abundance Based on Partial Population Estimates and Population Indices. Trends in Bold are Significantly Different from 0 at α=0.05 (Williams et al. 2011).

Stratum	Population (run)	Short-term Trend (95 percent CI)	Long-term Trend (95 percent CI)
Northern Coastal	**Humboldt Bay**		
	Freshwater Creek (winter)	-0.046 (-0.245, 0.153)	-
	Little River (winter)	**-0.231** (-0.418, -0.043)	
	Redwood Creek (summer)	**0.093** (0.011, 0.175)	-0.012 (-0.054, 0.029)

Stratum	Population (run)	Short-term Trend (95 percent CI)	Long-term Trend (95 percent CI)
North Mountain-Interior	**Upper Eel River (winter)**	**0.062** (0.001, 0.123)	-
North-Central Coastal	**Noyo River** SF Noyo River (winter)	0.004 (-0.115, 0.123)	-
Central Coast	**Gualala River** Wheatfield Fork (winter)	0.000 (-0.361, 0.361)	-

From available surveys, we estimate that the NC steelhead DPS has an annual abundance of 7,221 adults (Table 21).

Table 21. Geometric Mean Abundances of NC Steelhead Spawners by Population (Gallagher and Wright 2009, 2011, and 2012; Gallagher et al. 2013, Mattole Salmon Group 2011, Duffy 2011, Counts at Van Arsdale Fisheries Station), Harris and Thompson 2014, De Haven 2010, Metheny and Duffy 2014, Ricker et al. 2014, additional unpublished data provided by the NMFS SWFSC)

Stratum	Waterbody	Run	Years	Abundance	Expected Number of Outmigrants[a]
Northern Coastal	**Elk Creek**	**Winter**	2011, 2014	13	1,479
	Little River	**Winter**	2010-2014	10	1,138
	Mattole River	**Winter**	2012-2013	558	63,473
	Mattole River	**Summer**	2011-2015	92	10,465
	Redwood Creek	**Winter**	2010-2013	610	69,388
	Redwood Creek	**Summer**	2010-2014	7	796
	Prairie Creek	**Winter**	2007, 2008, 2010-2012	22	2,503
	Humboldt Bay	**Winter**	2011-2014	52	5,915
	Freshwater Creek	**Winter**	2010-2014	102	11,603
North Mountain-Interior	**Eel River**	**Winter**	2011-2015	389	44,249
	South Fork Eel River	**Winter**	2011-2014	574	65,293
	Van Duzen River	**Summer**	2011-2015	115	13,081
	Middle Fork Eel River	**Summer**	2010-2014	796	90,545
North-Central Coastal	**Big River**	**Winter**	2010-2014	465	52,894
	Caspar Creek	**Winter**	2010-2014	31	3,526
	Cottoneva Creek	**Winter**	2010, 2012, 2014	83	9,441

Stratum	Waterbody	Run	Years	Abundance	Expected Number of Outmigrants[a]
	Hare Creek	**Winter**	2010-2014	2	228
	Juan Creek	**Winter**	2012	39	4,436
	Noyo River	**Winter**	2010-2014	442	50,278
	SF Noyo River	**Winter**	2010-2014	79	8,986
	Pudding Creek	**Winter**	2010-2014	34	3,868
	Ten Mile River	**Winter**	2010-2014	382	43,453
	Usal Creek	**Winter**	2010-2013	54	6,143
	Wages Creek	**Winter**	2010, 2011, 2014	55	6,256
Central Coastal	**Albion River**	**Winter**	2010-2014	45	5,119
	Big Salmon Creek	**Winter**	2012-2013	84	9,555
	Brush Creek	**Winter**	2010-2014	6	683
	Garcia River	**Winter**	2010-2014	340	38,675
	Gualala River	**Winter**	2006-2010	1,066	121,258
	Navarro River	**Winter**	2010-2014	332	37,765
	North Fork Navarro River	**Winter**	2013-2014	342	38,903
Total				**7,221**	**821,389**

[a]Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally produced juvenile NC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile NC steelhead abundance estimates come from the escapement data (Table 21). For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of spawners – 3,610 females), 12.6 million eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 821,389 natural outmigrants annually. There are not currently hatchery NC steelhead included in this DPS.

2.2.1.22 California Coastal Chinook Salmon

Listed Hatchery Juvenile Releases – There are no listed hatchery programs for this ESU.

Adult spawners and expected outmigration – Although there is limited population-level estimates of abundance for CC Chinook salmon populations, Table 22 summarizes the information that is available for the major watersheds in the ESU. Based on this limited information, the current average run size for CC Chinook salmon ESU is 7,034 adults (Table 22).

Table 22. Average abundance for CC Chinook salmon natural-origin spawners (Metheny and Duffy 2014, PFMC 2013, Ricker et al. 2014, Mattole Salmon Group 2011, Potter Valley Irrigation District - Van Arsdale Fish Counts webpage, Sonoma Water - Chinook Salmon in the Russian River webpage).

Population	Years	Spawners	Expected Number of Outmigrants[ab]
Redwood Creek	2009-2013	1,745	317,067
Mad River	2010-2015	71	12,900
Freshwater Creek	2010-2015	6	1,090
Eel River mainstem	2010-2015	1,198	217,677
Eel River (Tomki Creek)	2010-2015	70	12,719
Eel River (Sproul Creek)	2010-2015	103	18,715
Mattole River	2007-2009, 2012, 2013	648	117,742
Russian River	2009 - 2014	3,137	569,993
Ten Mile River	2009 - 2014	6	1,090
Noyo River	2009 - 2014	14	2,544
Big River	2009 - 2014	13	2,362
Albion River	2009 - 2014	15	2,726
Navarro River	2009 - 2014	3	545
Garcia River	2009 - 2014	5	909
ESU Average		**7,034**	**1,278,078**

[a] Expected number of outmigrants=Total spawners*50 percent proportion of females*3,634 eggs per female*10 percent survival rate from egg to outmigrant.
[b] Based upon number of natural-origin spawners.

While we currently lack data on naturally produced juvenile CC Chinook salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. Juvenile CC Chinook salmon population abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Average fecundity for female CC Chinook salmon is not available. However, Healey and Heard (1984) indicates that average fecundity for Chinook salmon in the nearby Klamath River is 3,634 eggs for female. By applying an average fecundity of 3,634 eggs per female to the estimated 3,517 females returning (half of the average total number of spawners), and applying an estimated survival rate from egg to smolt of 10 percent, the ESU could produce roughly 1,278,078 natural outmigrants annually.

2.2.1.23 Sacramento River Winter-run Chinook Salmon

Listed Hatchery Juvenile Releases – Only one artificial propagation program is considered to be part of the SacR winter-run Chinook salmon ESU (79 FR 20802) – the Livingston Stone National Fish Hatchery (NFH). Annual releases from the hatchery are limited to 200,000 juvenile SacR winter-run Chinook salmon (all adipose-clipped) (NMFS consultation number WCR-2016-4012, Section 10(a)(1)(A) permit #16477).

Adult spawners and expected outmigration – The average abundance (2013-2017) for SacR winter-run Chinook salmon populations is 2,442 adult spawners (2,232 natural-origin and 210 hatchery-origin spawners; Table 23).

Table 23. Average abundance estimates for SacR winter-run Chinook salmon natural- and hatchery-origin spawners 2013-2017 (CDFW 2018).

Year	Natural-origin Spawners	Hatchery-origin Spawners	Percent Hatchery Origin	Expected Number of Outmigrants[a]
2013	5,920	164	2.7%	486,720
2014	2,627	388	12.9%	241,200
2015	3,182	258	7.5%	275,200
2016	1,409	137	8.9%	123,680
2017	795	180	18.5%	78,000
ESU Average[d]	**2,232**	**210**	**8.6%**	**195,354**

[a] Geometric mean (2013-2017) of post-fishery spawners.
[b] Expected number of outmigrants=Total spawners*40% proportion of females*2,000 eggs per female*10% survival rate from egg to outmigrant.

Juvenile SacR winter-run Chinook salmon abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Fecundity estimates for the ESU range from 2,000 to 5,500 eggs per female, and the proportion of female spawners in most populations is approximately 40 percent of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 977 females), the ESU is estimated to produce approximately 1.95 million eggs annually. The average survival rate in these studies was 10 percent, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10 percent, the ESU should produce roughly 195,354 natural outmigrants annually.

2.2.1.24 Central Valley Spring-run Chinook Salmon

Listed Hatchery Juvenile Releases – The Feather River Hatchery is the only ESA-listed hatchery for the CVS Chinook salmon (79 FR 20802). From 1999-2009, the hatchery has released, on average, 2,169,329 CVS Chinook salmon smolts (all adipose-clipped) (California HSRG 2012).

Adult spawners and expected outmigration – The average abundance[2] (2013-2017) for CVS Chinook salmon populations is 6,000 adult spawners (3,727 natural-origin and 2,273 hatchery-origin spawners; Table 24). Historic spawning habitat on the Feather River is blocked by Oroville Dam, so all CVS Chinook salmon are returned to the hatchery (Williams et al. 2016; CDFW 2018).

Table 24. Average abundance estimates for CVS Chinook salmon natural- and hatchery-origin spawners 2013-2017 (CDFW 2018).

[2] Average abundance calculations are the geometric mean. The geometric mean of a collection of positive data is defined as the nth root of the product of all the members of the data set, where n is the number of members. Salmonid abundance data tend to be skewed by the presence of outliers (observations considerably higher or lower than most of the data). For skewed data, the geometric mean is a more stable statistic than the arithmetic mean.

Population Name	Natural-origin Spawners[a]	Hatchery-origin Spawners[a]	% Hatchery Origin	Expected Number of Outmigrants[b]
Southern Cascades Stratum				
Battle Creek	191	0	0%	39,761
Mill Creek	302	0	0%	62,807
Deer Creek	409	0	0%	85,049
Butte Creek	2,750	0	0%	572,056
Big Chico Creek	0	0	0%	0
Antelope Creek	3	0	0%	598
Coastal Range Stratum				
Clear Creek	73	0	0%	15,143
Cottonwood / Beegum creeks	0.3	0	0%	60
Northern Sierra Stratum				
Feather River	0	2,273	100%	-
ESU Average	**3,727**	**2,273**	**37.9%**	**775,474**

[a] Geometric mean (2013-2017) of post-fishery spawners.
[b] Expected number of outmigrants=Total spawners*50% proportion of females*4,131 eggs per female*10% survival rate from egg to outmigrant.

The CDFG (1998) published estimates in which average fecundity of spring-run Chinook salmon is 4,161 eggs per female. By applying the average fecundity of 4,161 eggs per female to the estimated 1,862 females returning (half of the most recent five-year average of spawners), and applying an estimated survival rate from egg to smolt of 10 percent, the Sacramento River basin portion of the ESU could produce roughly 775 thousand natural outmigrants annually.

2.2.1.25 California Central Valley Steelhead

*Abundance and Productivity***.** Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock et al. (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the Red Bluff Diversion Dam (RBDD) declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations, and comprehensive steelhead population monitoring has not taken place in the Central Valley until recently, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and initial results of an adult escapement monitoring plan should be available by the time of the next status review.

Table 25. Abundance geometric means for adult CCV steelhead natural- and hatchery-origin spawners (CHSRG 2012, Hannon and Deason 2005, Teubert et al. 2011, additional unpublished data provided by the NMFS SWFSC)

Population	Years	Natural-origin Spawners	Hatchery-origin Spawners	Expected Number of Outmigrants[ab]
American River	2011-2015	208	1,068	145,145
Antelope Creek	2007	140	0	15,925
Battle Creek	2010-2014	410	1,563	224,429
Bear Creek	2008-2009	119	0	13,536
Cottonwood Creek	2008-2009	27	0	3,071
Clear Creek	2011-2015	463	0	52,666
Cow Creek	2008-2009	2	0	228
Feather River	2011-2015	41	1,092	128,879
Mill Creek	2010-2015	166	0	18,883
Mokelumne River	2006-2010	110	133	27,641
Total		**1,686**	**3,856**	**630,403**

[a] Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant
[b] Based upon number of natural-origin spawners

Historic CCV steelhead abundance is unknown. In the mid-1960’s, the California Department of Fish and Game (CDFG) (now CDFW) estimated CCV steelhead abundance at 26,750 fish (CDFG 1965). The CDFG estimate, however, is just a midpoint number in the CCV steelhead’s abundance decline—at the point the estimate was made, there had already been a century of commercial harvest, dam construction, and urbanization.

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams et al. 2011).

In contrast to the data from Chipps Island and the Central Valley Project and State Water Project fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the Central Valley compared to hatchery produced fish (NMFS 2011). Since 2003, fish returning to the Coleman NFH have been identified as wild (adipose fin intact) or hatchery produced (adipose-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely—ranging from 624 to 2,968 fish per year.

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally produced juvenile CCV steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile CCV steelhead abundance estimates come from the escapement data (Table 25). For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of hatchery- and natural-origin spawners – 2,771 females), 9.7 million eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 630,403 naturally produced outmigrants annually. In addition, hatchery managers could produce approximately 1.6 million listed hatchery juvenile CCV steelhead each year (Table 26).

Table 26. Expected Annual CCV Steelhead Hatchery Releases (CHSRG 2012).

Artificial propagation program	Clipped Adipose Fin
Nimbus Hatchery (American River)	439,490
Feather River Hatchery (Feather River)	**273,398**
Coleman NFH (Battle Creek)	**715,712**
Mokelumne River Hatchery (Mokelumne River)	172,053
Total Annual Release Number	**1,600,653**

2.2.1.26 Central California Coast Coho Salmon

Listed Hatchery Juvenile Releases – The CCC coho salmon ESU includes three artificial propagation programs (79 FR 20802). Recent hatchery releases for CCC coho salmon have averaged 165,880 LHAC juveniles (Table 27).

Table 27. Average juvenile CCC coho salmon hatchery releases.

Artificial propagation program	Watershed	Years	Clipped Adipose Fin
Don Clausen Fish Hatchery Captive Broodstock Program[a]	Russian River tributaries	2014-2018	132,680
Scott Creek/King Fisher Flats Conservation Program[b]	Gazos and San Vicente creeks	2018	12,000
Scott Creek Captive Broodstock Program[c]	Scott Creek	2013-2017	21,200
Average Annual Release Number			**165,880**

[a] Source - Sea Grant California - Hatchery Releases webpage
[b] Source - Monterey Bay Salmon & Trout Project webpage
[c] Source - NOAA Fisheries - Species in the Spotlight Action Plan Implementation Highlights webpage

Adult spawners and expected outmigration – The current average run size for the CCC coho salmon ESU is 2,259 fish (1,932 natural-origin; 327 hatchery produced*)* (Table 28).

Table 28. Geometric mean abundances of CCC coho salmon spawner escapements by population (Williams et al. 2016). Populations in bold font are independent populations.

Stratum	Population	Spawners		Expected Number of Outmigrants[b]
		Natural-origin	Hatchery-origin[a]	
Lost Coast – Navarro Point	**Ten Mile River**	69	-	4,830
	Usal Creek	4	-	280
	Noyo River	455	-	31,850
	Pudding Creek	184	-	12,880
	Caspar Creek	40	-	2,800
	Big River	183	-	12,810
	Little River	30		2,100
	Albion River	21	-	1,470
	Big Salmon Creek	3		210
Navarro Point – Gualala Point	**Navarro River**	102	-	7,140
	Greenwood Creek	3		210
	Garcia River	18	-	1,260
	Gualala River	-	-	-
Coastal	**Russian River**	364[c]	323	48,090
	Salmon Creek	-	-	-
	Walker Creek		-	-
	Lagunitas Creek	408	-	28,560
	Pine Gulch	2		140
	Redwood Creek	23	-	1,610
Santa Cruz Mountains	**Pescadero Creek**	1	-	70
	San Lorenzo River	1	-	70
	Waddell Creek	1	-	70
	Scott Creek	18	4	1,540
	San Vicente Creek	2	-	140
	Soquel Creek	-	-	-
ESU Total		**1,932**	**327**	**158,130**

[a] J. Jahn, pers. comm., July 2, 2013
[b] Expected number of outmigrants=Total spawners*50% proportion of females*2,000 eggs per female*7% survival rate from egg to outmigrant
[d] Arithmetic mean used due to unavailability of geometric mean

While we currently lack data on how many natural juvenile coho salmon this ESU produces, it is possible to make rough estimates of juvenile abundance from adult return data. Sandercock (1991) published fecundity estimates for several coho salmon stocks; average fecundity ranged from 1,983 to 5,000 eggs per female. By applying a very conservative value of 2,000 eggs per female to an estimated 1,129 females returning (50 percent of the run, including the Russian River hatchery returns which are allowed to spawn in the wild) to this ESU, one may expect approximately 2.2

million eggs to be produced annually. Nickelson (1998) found survival of coho salmon from egg to parr in Oregon coastal streams to be around 7 percent. Thus, we can estimate that roughly the Central California Coast ESU produces 158,130 juvenile coho salmon annually.

2.2.1.27 Central California Coast Steelhead

The CCC steelhead DPS includes winter-run steelhead populations from the Russian River (Sonoma County) south to Aptos Creek (Santa Cruz County) inclusive and eastward to Chipps Island (confluence of the Sacramento and San Joaquin rivers) and including all drainages of San Francisco, San Pablo, and Suisun bays (Table 29).

Table 29. Historical CCC Steelhead Populations (NMFS 2011).

North Coastal	Austin Creek, Salmon Creek, Walker Creek, Lagunitas Creek, Green Valley Creek
Interior	Dry Creek, Maacama Creek, Mark West Creek, Upper Russian River
Santa Cruz Mountains	Aptos Creek, Pescadero Creek, Pilarcitos Creek, San Lorenzo River, San Gregorio Creek, Scott Creek, Soquel Creek, Waddell Creek
Coastal San Francisco Bay	Corte Madera Creek, Guadalupe River, Miller Creek, Novato Creek, San Francisquito Creek
Interior San Francisco Bay	Alameda Creek, Coyote Creek, Napa River, Petaluma River, San Leandro Creek, San Lorenzo Creek

Table 30. Approximate annual releases of hatchery CCC steelhead (J. Jahn, pers. comm., July 2, 2013).

Artificial propagation program	Adipose Fin-Clipped
Scott Creek/Kingfisher Flat Hatchery	3,220
San Lorenzo River	19,125
Don Clausen Fish Hatchery	380,338
Coyote Valley Fish Facility	246,208
Total Annual Release Number	**648,891**

*Abundance and Productivity***.** Historic CCC steelhead abundance is unknown. In the mid-1960's, CDFG estimated CCC steelhead abundance at 94,000 fish (CDFG 1965). The CDFG estimate, however, is just a midpoint number in the CCC steelhead's abundance decline—at the point the estimate was made, there had already been a century of commercial harvest and urbanization. Current CCC steelhead abundance is still not well known. Multiple short-term studies using different methodologies have occurred over the past decade.

Data for both adult and juvenile abundance are limited for this DPS. While we currently lack data on naturally-produced juvenile CCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile CCC steelhead abundance estimates come from the escapement data (Table 31). All returnees to the hatcheries do not contribute to the natural population and are not used in this calculation. For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of natural-origin spawners – 1,094 females), 3.8 million eggs are expected to be produced annually. In addition, hatchery managers could produce 648,841 listed hatchery juvenile CCC steelhead each year (Table 30). With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 248,771 natural outmigrants annually (Table 31).

Table 31. Geometric Mean Abundances of CCC Steelhead Spawners Escapements by Population (Ettlinger et al. 2012, Jankovitz 2013.

			Abundance		
Stratum	**Waterbody**	**Years**	**Natural Origin**	**Hatchery Origin**	**Expected Number of Outmigrants[ab]**
Northern Coastal	Austin Creek	2010-2012	63	-	7,166
	Lagunitas Creek	2009-2013	71	-	8,076
	Pine Gulch Creek	2010-2014	37		4,209
	Redwood Creek	2010-2014	18		2,048
	Walker Creek	2007-2010	29	-	3,299
Interior	Dry Creek	2011-2012	33	-	3,754
	Russian River	2008-2012	230	3,451	26,163
Santa Cruz Mountains	Aptos Creek	2007-2011	249	-	28,324
	Pescadero	2013-2015	361	-	41,064
	Gazos Creek	2013-2015	30	-	3,413
	Waddell Creek	2013-2014	73	-	8,304
	San Gregorio Creek	2014-2015	135	-	15,356
	San Lorenzo River	2013-2015	423	319	48,116
	San Pedro Creek	2013	38		4,323
	San Vicente Creek	2013-2015	35		3,981
	Scott Creek	2011-2015	120	96	13,650
	Soquel Creek	2007-2011	230	-	26,163
Central Coastal	Napa River	2009-2012	12	-	1,365
		Totals	**2,187**	**3,866**	**248,771**

[a]Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant
[b]Based upon natural-origin spawner numbers

Good et al. (2005) concluded that due to past declines, threats to genetic integrity, and available abundance data the CCC steelhead DPS was not presently in danger of extinction but was likely to become so in the future. While data indicated that CCC steelhead remain present in the Santa Cruz mountains, reducing overall extinction risk of the DPS, subsequent reviews of DPS viability (Williams et al. 2011, NMFS 2016e) have concluded there was not sufficient information to indicate any change in DPS viability, although they acknowledge high levels of uncertainty surrounding most populations (NMFS 2016e). This indicates the DPS may not be viable in the long term. DPS populations that historically provided enough steelhead strays to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead have maintained a wide distribution throughout the DPS, roughly approximating the known historical distribution, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid species in worse condition (*e.g.,* CCC coho salmon).

Current abundance trend data for the CCC steelhead remains extremely limited. Only the Scott Creek population provides enough of a time series to examine trends, and this population is influenced by hatchery origin fish. Natural-origin spawners have experienced a significant downward trend (slope = -0.220; p = 0.036) (Williams et al. 2011). Since we only have trend information on Scott Creek, trends for the majority of the DPS is unknown although most of the populations are presumed to be extant.

2.2.1.28 South-Central California Coast Steelhead

S-CCC steelhead occupy rivers from the Pajaro River (Santa Cruz County, California), inclusive, south to, but not including, the Santa Maria River (San Luis Obispo County, California) (Table 32). Most rivers in this DPS drain from the San Lucia Mountain range, the southernmost section of the California Coast Ranges. Many stream and rive mouths in this area are seasonally closed by sand berms that form during the low water flows of summer. The climate is drier than for the more northern DPSs with vegetation ranging from coniferous forest to chaparral and coastal scrub.

Table 32. Historical S-CCC Steelhead Populations (NMFS 2012).

Population Groups	Populations (north to south)
Interior Coast Range	Pajaro River, Gabilan Creek, Arroyo Seco, Upper Salinas Basin
Carmel River Basin	Carmel River
Big Sur Coast	San Jose Creek, Malpaso Creek, Garrapata Creek, Rocky Creek, Bixby Creek, Little Sur River, Big Sur River, Partington Creek, Big Creek, Vicente Creek, Limekiln Creek, Mill Creek, Prewitt Creek, Plaskett Creek, Willow Creek (Monterey Co.), Alder Creek, Villa Creek (Monterey Co.), Salmon Creek
San Luis Obispo Terrace	Carpoforo Creek, Arroyo de la Cruz, Little Pico Creek, Pico Creek, San Simeon Creek, Santa Rosa Creek, Villa Creek (SLO Co.), Cayucos Creek, Old Creek, Toro Creek, Morro Creek, Chorro Creek, Los Osos Creek, Islay Creek, Coon Creek, Diablo Canyon, San Luis Obispo Creek, Pismo Creek, Arroyo Grande Creek

Abundance and Productivity. Historic S-CCC steelhead abundance is unknown. In the mid-1960s, CDFG estimated S-CCC steelhead abundance at 17,750 fish (CDFG 1965). The CDFG estimate, however, is just a midpoint number in the S-CCC steelhead’s abundance decline—at the point the estimate was made, there had already been a century of commercial harvest and coastal development. Current S-CCC steelhead abundance is still not well known. Multiple short-term studies using different methodologies have occurred over the past decade.

Table 33. Geometric Mean Abundances of S-CCC Steelhead Spawners from 2001-2012 Escapements by Population.

Stratum	Waterbody	Years	Abundance	Expected Number of Outmigrants[a]
Interior Coast Range	**Pajaro River[b]**	2007-2011	35	3,981
	Salinas River[c]	2011-2013	21	2,389
Carmel River Basin	**Carmel River[d]**	2009-2013	318	36,173
Big Sur Coast	**Big Sur River[e]**	2010	11	1,251
	Garrapata Creek[f]	2005	17	1,934
San Luis Obispo Terrace	**Arroyo Grande Creek[g]**	2006	18	2,048
	Chorro Creek[h]	2001	2	228
	Coon Creek[i]	2006	3	341
	Los Osos Creek[h]	2001	23	2,616
	San Simeon Creek[j]	2005	4	455
	Santa Rosa Creek[k]	2002-2006	243	27,641
Total			**695**	**79,057**

[a]Expected number of outmigrants=Total spawners*50 percent proportion of females*3,500 eggs per female*6.5 percent survival rate from egg to outmigrant
[b]Source: http://scceh.com/LinkClick.aspx?fileticket=dRW_AUu1EoUpercent3D&tabid=1772
[c]Kraft et al. 2013
[d]Sources: here and here.
[e]Allen and Riley 2012
[f]Garrapata Creek Watershed Council 2006
[g]Source: http://www.coastalrcd.org/zone1-1a/Fisheriespercent20Studies/AG_Steelhead_Report_Draft-small.pdf
[h]Source: http://www.coastalrcd.org/images/cms/files/MBpercent20Steelheadpercent20Abundpercent20andpercent20Distpercent20Report.pdf
[i]City of San Luis Obispo 2006
[j]Baglivio 2012
[k]Stillwater Sciences et al. 2012

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally-produced juvenile S-CCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. The estimated average adult run size is 695 (Table 33). Juvenile S-CCC steelhead abundance estimates come from the escapement data. For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of spawners – 348 females), 1.2 million eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 79,057 natural outmigrants annually (Table 33).

The natural abundance number should be viewed with caution, however, as it only addresses one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) the available data are not inclusive of all populations; (2) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (3) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (4) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (5) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

The Carmel River contains the biggest spawning run of the DPS (Williams et al. 2011). Two dams and reservoirs (Los Padres and San Clemente) are built in the drainage and are monitored for fish abundance. In 2013, the San Clemente dam has begun to be removed, and when completed the Carmel River will be rerouted. While improving steelhead habitat, this will remove one of the few locations where steelhead are monitored within the DPS. The Santa Rosa Creek has the second most abundant run for the DPS, but it is poorly studied. Overall, this steelhead DPS is too data poor for abundance to statistically test abundance trends.

2.2.1.29 Southern California Steelhead

Description, Geographic Range. On August 18, 1997, NMFS listed SC steelhead as an endangered species (62 FR 43937). NMFS concluded that the SC steelhead DPS was in danger of extinction throughout all or a significant portion of its range. There is no hatchery production in support of this DPS. The geographic range of the SC steelhead DPS extends from the Santa Maria River, near Santa Maria, to the California–Mexico border, which represents the known southern geographic extent of the anadromous form of *O. mykiss*.

Spatial Structure and Diversity. NMFS described historical and recent steelhead abundance and distribution for the southern California coast through a population characterization (Boughton et al. 2006). Surveys in Boughton et al. (2005) indicate between 58 percent and 65 percent of the historical steelhead basins currently harbor *O. mykiss* populations at sites with connectivity to the ocean. Most of the apparent losses of steelhead were noted in the south, including Orange and San Diego Counties (Boughton et al. 2005).

Abundance and Productivity. While 46 drainages support the SC steelhead DPS (Boughton et al. 2005), only 10 population units possess a high and biologically plausible likelihood of being viable and independent[3] (Boughton et al. 2006). Very little data regarding abundances of Southern California Coast steelhead are available, but the picture emerging from available data suggest very small (<10 fish) but surprisingly consistent annual runs of anadromous fish across the diverse set of basins that are currently being monitored (Williams et al. 2011). The most significant population that has been recently monitored is in Topanga Creek, where mark-recapture studies were done in 2007-2008. According to the authors (Bell et al. 2011), that data indicated a population of resident fish whose abundance is on the order of 500 individuals, including all size and age classes in

[3] Independent population: a collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations (Boughton et al. 2006).

Topanga Creek. It is believed that population abundance trends can significantly vary based on yearly rainfall and storm events within the range of the Southern California Coast DPS (Williams et al. 2011). A relatively large number of adult steelhead were observed in 2008, two years after an extended wet spring that presumably gave smolts ample opportunity to migrate to the ocean. Some of the strength of the 2008 season may also be an artifact of conditions that year. Low rainfall appears to have caused many spawners to get trapped in freshwater, where they were observed during the summer; in addition, low rainfall probably improved conditions for viewing fish during snorkel surveys, and for trapping fish in weirs (Williams et al. 2011). Much of the data pertaining to the incidence of adult anadromous *O. mykiss* in the SC steelhead DPS is not appropriate to be used to generate abundance estimates. However, the annual presence and count of adult SC steelhead has been documented annually in a number of streams (Table 34).

Table 34. Mean and Total Observations of Adult Anadromous SC Steelhead from 2005 to 2014. (Santa Ynez River Adaptive Management Committee 2009, United States Bureau of Reclamation 2011, Hovey and O'Brien 2013, Dagit et al. 2015, Casitas Municipal Water District (2005 through 2014), United Water Conservation District (2005 through 2014), Mark Capelli unpublished data, George Sutherland unpublished data, Resource Conservation District of the Santa Monica Mountains unpublished data, Mauricio Gomez unpublished data, Dave Katjaniak unpublished data)

		Observations	
System	**Years**	**Total**	**Mean Annual**
Santa Ynez River	2005 - 2014	29	2.9
Ventua River	2006 - 2014	13	1.4
Santa Clara River	2005 - 2014	5	0.5
Goleta Slough	2005 - 2014	6	0.6
Mission Creek	2005 - 2014	18	1.8
Carpinteria Creek	2008	3	-
Conejo Creek	2013	1	-
Malibu Creek	2006 - 2014	23	2.6
Topanga Creek	2005 - 2014	8	0.8
Ballona Creek	2008	2	-
San Juan Creek	2005 - 2014	5	0.5
Santa Margarita Creek	2009	1	-

San Luis Rey River	2007	2	-
Las Penasquito Creek	2012	1	-
	Total	**117**	**11.1**

There is little new evidence to suggest that the status of the Southern California DPS has changed appreciably in either direction since publication of the most recent collections of status reviews (Good et al. 2005; NMFS 2011d; Williams et al. 2011). The observations of adult SC steelhead for the last ten years of only average around 11 individuals annually (Table 34). However, the most recent SC steelhead recovery plan found no evidence that the annual return of anadromous adults has changed since the original 2005 status review, which estimated the number to be less than 500 individuals (Busby et al. 1996, NMFS 2012d). Given this range of expected annual returning spawners, the most conservative estimate of juvenile production based on those returns would be based on the assumption that the number of returning spawners for the DPS is just 11 fish. For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of spawners – 5.5 females), 19,425 eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce a minimum of 1,262 natural outmigrants annually. This estimate of outmigrants is derived from the most conservative estimate within the range of the abundance estimate of adult anadromous returns, but further complicating this calculation, the SC steelhead DPS is also influenced by the presence of a significant unlisted resident population of *O. mykiss*. Due to the phenotypic plasticity between these two life history strategies that has been demonstrated in *O. mykiss* (Pearse 2009), it is possible that additional outmigrants may be derived from this unlisted resident population, or that some residual offspring of anadromous parents may express a resident life history. For that reason, differentiating anadromous and resident juveniles pre-smoltification is not possible, so for precautionary reasons, all juvenile *O. mykiss* that occur within the SC steelhead range are considered to be SC steelhead.

Threats and Limiting Factors. The majority of lost populations (68 percent) of SC steelhead have been associated with anthropogenic barriers to steelhead migration (e.g., dams, flood-control structures, culverts, etc.). Additionally, investigators have found that barrier exclusions are statistically associated with highly-developed watersheds. SC steelhead populations experience a high magnitude of threat to a small number of extant populations vulnerable to extirpation due to loss of accessibility to freshwater spawning and rearing habitat, low abundance, degraded estuarine habitats and watershed processes essential to maintain freshwater habitats (NMFS 2011d). The practice of fire suppression within the range of this DPS, and the associated potential for increased fire intensity and duration, has also been identified as a potential threat to the steelhead in this DPS (62 FR 43937). The recovery potential is low to moderate due to the lack of additional populations, lack of available/suitable freshwater habitat, steelhead passage barriers, and inadequate instream flow.

Status Summary. There is little new evidence to suggest that the status of the SC steelhead DPS has changed appreciably in either direction since publication of the most recent collections of status reviews (Good et al. 2005; NMFS 2011d; Williams et al. 2011, Williams et al. 2016).

2.2.1.30 Southern Eulachon

For most S eulachon DPS spawning runs, abundance is unknown with the exception of the Columbia and Fraser River spawning runs. Beginning in 1995, the Canada's Department of Fisheries and Oceans (DFO) started annual surveys in the Fraser River. These surveys consisted of estimating larval density, measuring river discharge, and using estimates of relative fecundity to determine spawning biomass (Hay et al. 2002). Beginning in 2011, Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) began instituting similar monitoring in the Columbia River. From 2015 through 2019, the eulachon spawner population estimate for the Fraser River is 2,877,962 adults and for the Columbia River 29,151,081 adults (Table 35). The combined spawner estimate from the Columbia and Fraser rivers is 32.03 million eulachon.

Table 35. Southern DPS eulachon spawning estimates for the lower Fraser River (British Columbia, Canada) and Columbia River (Oregon/Washington states, USA).

Year	Fraser River		Columbia River	
	Biomass estimate (metric tons)[a]	Estimated spawner population[b]	Biomass estimate (metric tons)	Estimated spawner population[c]
2011	31	765,445	1503	37,000,000
2012	120	2,963,013	1463	36,000,000
2013	100	2,469,177	4469	110,000,000
2014	66	1,629,657	7313	180,000,000
2015	317	7,827,292	4469	110,000,000
2016	44	1,086,438	2217	54,556,500
2017	35	864,212	744	18,307,100
2018	408	10,074,244	167	4,104,300
2019	108	2,666,712	1897	46,684,800
2015-2019[d]	**117**	**2,877,962**	**1,184**	**29,151,081**

[a] DFO 2020
[b] Estimated population numbers are calculated as 11.16 eulachon per pound.
[c] Langness et al. 2020
[d] Five-year geometric mean of mean eulachon biomass estimates (2015-2019).

2.2.1.31 Southern Green Sturgeon

Green sturgeon are composed of two DPSs with two geographically distinct spawning locations. The northern DPS spawn in rivers north of and including the Eel River in Northern California with known spawning occurring in the Eel, Klamath, and Trinity rivers in California and the Rogue and Umpqua rivers in Oregon. The southern DPS spawn in rivers south of the Eel River which is now restricted to the Sacramento River. Since 2010, Dual Frequency Identification Sonar (DIDSON) surveys of aggregating sites in the upper Sacramento River for S green sturgeon have been conducted. Annually, green sturgeon adults were monitored with tagged individuals showing a mean spawning periodicity was 3.69 years (Mora et al. 2018). Results from these surveys for S green sturgeon resulted in an estimate of 4,387 juveniles (freshwater stage, less than 60 cm length, and one to three years of age), 11,055 sub-adults (3-20 years and 60-165 cm length), and 2,106 adults (greater than 165 cm in length and older than 20 years) (Table 36; Mora et al. 2018).

Table 36. Six-year geometric mean (2010-2015) abundance estimate of SDPS green sturgeon (Mora et al. 2018).

Life stage	Estimate	95% Confidence Interval	
		Low	High
Juvenile	4,387	2,595	6,179
Sub-adult	11,055	6,540	15,571
Adult	2,106	1,246	2,966
ESU abundance[a]	**17,548**	**12,614**	**22,482**

2.2.2 Status of the Species' Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (*e.g*., sites with conditions that support spawning, rearing, migration and foraging).

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 37, below.

Table 37. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	09/02/2005 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Primary constitute elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Puget Sound steelhead	02/24/2016 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Puget Sound/Georgia Basin DPS of bocaccio	11/13/2014 79 FR 68042	Critical habitat for bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for all three species, critical habitat was not designated in that area. Based on the natural history of bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: 1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.
Puget Sound/Georgia Basin DPS of yelloweye rockfish	11/13/2014 79 FR 68042	Critical habitat for yelloweye rockfish includes 414.1 square miles of deepwater marine habitat in Puget Sound, all of which overlaps with areas designated for canary rockfish and bocaccio. No nearshore component was included in the CH listing for juvenile yelloweye rockfish as they, different from bocaccio and canary rockfish, typically are not found in intertidal waters (Love et al. 1991). Yelloweye rockfish are most frequently observed in waters deeper than 30 meters (98 ft) near the upper depth range of adults (Yamanaka et al. 2006). Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.
Hood Canal summer-run chum salmon	09/02/2005 70 FR 52630	Critical habitat for Hood Canal summer-run chum salmon includes 79 miles and 377 miles of nearshore marine habitat in HC. Primary constituent elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Upper Columbia River spring-run Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		(NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Middle Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Snake River spring/summer-run Chinook salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River fall-run Chinook salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River basin steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River sockeye salmon	10/25/1999 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015a). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Lower Columbia River Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Lower Columbia River coho salmon	02/24/2016 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Lower Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Columbia River chum salmon	09/02/2005 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Upper Willamette River Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Upper Willamette River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Oregon Coast coho salmon	02/11/2008 73 FR 7816	Critical habitat encompasses 13 subbasins in Oregon. The long-term decline in Oregon Coast coho salmon productivity reflects deteriorating conditions in freshwater habitat as well as extensive loss of access to habitats in estuaries and tidal freshwater. Many of the habitat changes resulting from land use practices over the last 150 years that contributed to the ESA-listing of Oregon Coast coho salmon continue to hinder recovery of the populations; changes in the watersheds due to land use practices have weakened natural watershed processes and functions, including loss of connectivity to historical floodplains, wetlands and side channels; reduced riparian area functions (stream temperature regulation, wood recruitment, sediment and nutrient retention); and altered flow and sediment regimes (NMFS 2016b). Several historical and ongoing land uses have reduced stream capacity and complexity in Oregon coastal streams and lakes through disturbance, road building, splash damming, stream cleaning, and other activities. Beaver removal, combined with loss of large wood in streams, has also led to degraded stream habitat conditions for coho salmon (Stout et al. 2012)
Southern Oregon/Northern California Coast coho salmon	05/05/1999 64 FR 24049	Critical habitat includes all areas accessible to any life-stage up to long-standing, natural barriers and adjacent riparian zones. SONCC coho salmon critical habitat within this geographic area has been degraded from historical conditions by ongoing land management activities. Habitat impairments recognized as factors leading to decline of the species that were included in the original listing notice for SONCC coho salmon include: 1) Channel morphology changes; 2) substrate changes; 3) loss of in-stream roughness; 4) loss of estuarine habitat; 5) loss of

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		wetlands; 6) loss/degradation of riparian areas; 7) declines in water quality; 8) altered stream flows; 9) fish passage impediments; and 10) elimination of habitat
Northern California steelhead	9/2/2005 70 FR 52488	There are approximately 3,028 miles of stream habitats and 25 square miles of estuary habitats designated as critical habitat for NC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. NC steelhead PBFs are sites and habitat components which support one or more life stages. There are 50 watersheds within the range of this DPS. Nine watersheds received a low rating, 14 received a medium rating, and 27 received a high rating of conservation value to the DPS. Two estuarine habitats, Humboldt Bay and the Eel River estuary, have high conservation value ratings. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Coastal Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,475 miles of stream habitats and 25 square miles of estuary habitats. There are 45 watersheds within the range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating. PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. Since designation, critical habitat for this species has continued to be. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Sacramento River winter-run Chinook salmon	06/16/1993 58 FR 33212 Modified 03/23/1999 64 FR 14067	Critical habitat includes the following waterways, bottom and water of the waterways and adjacent riparian zones: The Sacramento River from Keswick Dam, Shasta County (RK 486) to Chipps Island (RK 0) at the westward margin of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. The critical habitat for this species was designated before the CHART team process, thus watersheds have not yet been evaluated for conservation value. Since designation, critical habitat for this species has continued to be degraded. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central Valley spring-run Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,373 miles of stream habitats and 427 square miles of estuary habitats in 37 watersheds. The CHART rated seven watersheds as having low, three as having medium, and 27 as having high conservation value to the ESU. Four of these watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex, which provides rearing and migratory habitat for the ESU. PBFs include freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Central Valley steelhead	9/2/2005 70 FR 52488	There are approximately 2,308 miles of stream habitats and 254 square miles of estuary habitats designated as critical habitat for CCV steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCV steelhead PBFs are those sites and habitat components which support one or more life stages. There are 67 watersheds within the range of this DPS. Twelve watersheds received a low rating, 18 received a medium rating, and

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		37 received a high rating of conservation value to the DPS. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central California Coast coho salmon	05/05/1999 64 FR 24049	Critical habitat encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California, including two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. Critical habitat includes all waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). NMFS has identified several dams in the CCC coho salmon critical habitat range that currently block access to habitats historically occupied by coho salmon. However, NMFS has not designated these inaccessible areas as critical habitat because the downstream areas are believed to provide sufficient habitat for conserving the ESUs. The critical habitat for this species was designated before the CHART team process, thus watersheds have not yet been evaluated for conservation value. Since designation, critical habitat for this species has continued to be degraded. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,465 miles of stream habitats and 386 square miles of estuary habitats designated as critical habitat for CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 46 watersheds within the range of this DPS. For conservation value to the DPS, fourteen watersheds received a low rating, 13 received a medium rating, and 19 received a high rating. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.
South-Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,249 miles of stream habitats and three square miles of estuary habitats designated as critical habitat for S-CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. S-CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 30 watersheds within the range of this DPS. For conservation value to the DPS, six watersheds received a low rating, 11 received a medium rating, and 13 received a rated high. Morro Bay, an estuarine habitat, is used as rearing and migratory habitat for spawning and rearing steelhead. S-CCC steelhead inhabit coastal river basins from the Pajaro River south to, but not including, the Santa Maria River. Major watersheds include Pajaro River, Salinas River, Carmel River, and numerous smaller rivers and streams along the Big Sur coast and southward. Only winter-run steelhead are found in this DPS. The climate is drier and warmer than in the north that is reflected in vegetation changes from coniferous forests to chaparral and coastal scrub. The mouths of many rivers and streams in this DPS are seasonally closed by sand berms that form during the low stream flows of summer. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Southern California steelhead	9/2/2005 70 FR 52488	Critical habitat consists of 708 miles of stream habitat from 32 watersheds, with almost all occupied habitat from southern San Luis Obispo at the Santa Maria River to northern San Diego County at the San Mateo Creek designated. Within occupied habitat all military lands are excluded. There are also portions excluded due to economic considerations. Most watersheds south of Malibu Creek were not designated, though San Juan Creek and San Mateo Creek were designated. There are two general types of watersheds within the range of this DPS: those with short coastal streams that drain mountain ranges directly adjacent to the coast, and watersheds that contain larger river systems that continue inland through gaps in the coastal ranges. The rivers and streams in this area often have interrupted base flow patterns due to geologic formations and precipitation patterns that have strong seasonality. Restoration efforts are driven by two primary strategies. The first is working toward solutions that address fundamental causes of degradation. The second is based on resilience against climate change and harmony between human communities and this DPS.
Southern DPS of eulachon	10/20/2011 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Southern DPS of green sturgeon	10/09/2009 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays, as listed in Table 1 in USDC (2009). The CHART identified several activities that threaten the PBFs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the bays and estuaries, as well as the growth and reproductive health of Southern DPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom (but result in beneficial or adverse effects on prey resources for green sturgeon).

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Southern resident killer whale	11/29/2006 71 FR 69054	Critical habitat consists of three specific marine areas of inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural history of the Southern Residents and their habitat needs, NMFS identified three PBFs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging Water quality in Puget Sound, in general, is degraded. On September 19, 2019 NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,626.6 square miles (mi\2\) (40,472.7 square kilometers (km\2\)) of marine waters between the 6.1-meter (m) (20 feet (ft)) depth contour and the 200-m (656.2 ft) depth contour from the U.S. international border with Canada south to Point Sur, California. The proposed rule to revise critical habitat designation was based on new information about the SRKW's habitat use along the coast.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this opinion, the action area includes nearly all river reaches accessible to listed Chinook salmon, chum salmon, coho salmon, sockeye salmon, and steelhead in all sub-basins of Washington, Oregon, California and much of Idaho. Additionally, the action area includes all marine waters off the West Coast of the contiguous United States (including nearshore waters, from California to the Canadian border and Puget Sound) accessible to listed Chinook salmon, chum salmon, coho salmon, sockeye salmon, steelhead, eulachon, green sturgeon, and rockfish.

Where it is possible to narrow the range of the research, the effects analysis would take that limited geographic scope into account when determining the proposed actions' impacts on the species and their critical habitat (see permit summaries below for the instances in which this would be applicable). Still, the action area is generally spread out over much of Idaho, Oregon, Washington and California. It is also discontinuous. That is, there are large areas in between the various actions' locations where listed salmonids, sturgeon, eulachon, rockfish, etc., do exist, but where they would not be affected to any degree by any of the proposed activities. As noted earlier, the proposed actions could affect the killer whales' prey base (Chinook salmon) and those effects are described in the Not Likely to Adversely Affect section (2.11).

In most cases, the proposed research activities would take place in individually very small sites. For example, the researchers might electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of stream, or operate a screw trap in a few tens of square feet of habitat. Many of the proposed research activities would take place in designated critical habitat. More detailed habitat information (i.e., migration barriers, physical and biological habitat features, and special management considerations) for species considered in this opinion may be found in the Federal Register notices designating critical habitat (Table 37).

2.3.1. Action Areas for the Individual Permits

Permit 1415-5R – The proposed activities would take place in the Sacramento River and in Clear and Battle Creeks in the Central Valley, California.

Permit 1440-3R – The proposed activities would take place throughout the San Francisco Bay-Delta Region, California.

Permit 13675-3R – The proposed activities would take place in the Sacramento River, CA.

Permit 15486-3R – The proposed work under this permit would be widely distributed across portions of Idaho, Oregon, and Washington States. In any given year, the work could take place in the headwaters of tributaries to the Clearwater Rover in Idaho, the Puget Sound and Columbia River in Washington, and the Willamette River and the Columbia River in Oregon, as well as in Oregon coastal river systems. The minimally intrusive nature of the proposed activities (electrofishing) is such that we do not expect the work to have measurable downstream effects.

Permit 15549-3R – The trapping and tagging portions of the research would take place at fixed points in Satus Creek (RK 1.5), Ahtanum Creek (RK 3.5), and Toppenish Creek (RK 48) in Washington State. The electrofishing portion would take place in the headwater portions of those three creeks. The minimally intrusive nature of the proposed activities is such that we do not expect the work to have measurable downstream effects.

Permit 15611-3R – The research would take place at a fixed trap facility located at RM 47.5 of the Toutle River (just upstream from its confluence with the Green River) in Washington State. This work is minimally intrusive, has been evaluated in the past, and has never been found to have any downstream effects.

Permit 16274-2R – The proposed activities would take place in CA north coastal streams in Mendocino and Sonoma counties on Mendocino Redwood Company lands.

Permit 17077-3R - The proposed activities would take place in the Sacramento-San Joaquin Delta and Suisun Marsh in the Central Valley, CA.

Permit 17219-3R – The proposed activities would take place in coastal streams throughout California.

Permit 17351-2R – The proposed activities would take place in the Chetco, Smith, Lower Klamath, Mad-Redwood, and Lower Eel watersheds in Northern California.

Permit 18696-5M – The proposed activities would take place in various locations on the Snake River—though primarily in the reservoir behind Lower Granite Dam. In total, the research could extend from the confluence of the Snake and Grande Ronde Rivers to River mile 247, but would primarily be located in Lower Granite Reservoir. Based on previous evaluations, we do not expect that the research would have any downstream effects.

Permit 18908-2R – The proposed activities would take place at multiple locations in side channels and floodplain portions of tributaries between river mile 18 and 78 of the Skagit River in Washington state. Up to six different sites and up to three locations within a site would be sampled each year (each site no more than twelve times per year, and not more frequently than once every two weeks). Seine netting from the bank would be confined to targeted areas that are typically very low gradient (<1%), 15 to 50 feet wide, one to three feet deep, and silt or sand-bedded with velocities below one foot per second. The minimally intrusive nature of the proposed activities is such that they are not expected to have any measurable downstream effects.

Permit 19320-2R – The proposed research would take place in the marine environment of the California coast off the Smith River, the Klamath River, Mussel Point, Trinidad Head, the Eel River, Big Flat, the Albion River, Gualala Point, Fort Ross, Tomales Bay, Bolinas Bay, Pillar Point, and Pidgeon Point. Because the work would take place in the ocean, there are no downstream effects.

Permit 19738-2R – The proposed activities would take place at a variety of sites in small headwater streams on state managed lands in Whatcom, Skagit, Snohomish, and northern King Counties in Washington state. Backpack electrofishing would primarily be conducted at sites above known or presumed barriers to anadromy, although some sampling reaches may be within the upper extent of Puget Sound Chinook salmon and steelhead distribution—which this work aims to determine. The surveys would be presence/absence electrofishing surveys that are expected to be minimally intrusive and not expected to have any measurable downstream effects.

Permit 19741-2R – The proposed work would take place in the lower reaches of several streams in Yakima River subbasin of Central Washington: Rock Creek, Quartz Creek, Squaw Creek, Luna Creek, Harrison Creek, Wood Creek and Pine Creek. The minimally intrusive nature of the proposed activities (electrofishing, screw trapping) is such that we do not expect the work to have measurable downstream effects.

Permit 22482-2R – The proposed research would all take place in the lower 20 miles of the Willamette River in Oregon. The minimally intrusive nature of the proposed activities (beach seining) is such that we do not expect the work to have measurable downstream effects.

Permit 23029-2R – The proposed activities would take place at designated sampling sites in several Puget Sound estuaries and bays, including the Skagit, Stillaguamish, Puyallup, Nisqually, Snohomish, Deschutes, and Duwamish estuaries, as well as Port Madison, Shilshole Bay, and Sinclair Inlet in Washington state. Locations would be sampled by otter trawl, where an approximately 200 m area would be sampled at a depth of two to ten meters over a ten minute period, and may be sampled by deploying beach seines under 40m long with a maximum depth of less than three meters. The minimally intrusive nature of the proposed activities and the fact that they would take place in the marine environment signify that they are very unlikely to have any measurable effects on adjacent areas.

Permit 23649-2M – The proposed activities would take place throughout a one-mile section of the Crooked River downstream from Bowman Dam in Central Oregon. A screw trap will be located as closely as possible to the Bowman Dam outlet structure, and the researchers would electrofish the one mile of river below that. The minimally intrusive nature of the proposed activities is such that we do not expect the work to have measurable downstream effects.

Permit 24151 – The proposed research would take place in Tahkenitch Lake, Oregon (and tributaries to it). The minimally intrusive nature of the proposed activities (beach seining, minnow trapping, electrofishing), and the fact the most activities will take place in a lake indicates that the work is very unlikely to have any measurable downstream effects.

Permit 24255 – The proposed activities would take place in the Sacramento-San Joaquin Delta including Suisun Marsh and Grizzly Bay.

Permit 24367 – The proposed activities would take place at nearshore sites in Puget Sound, including along the San Juan Islands, in Whidbey Basin and along both sides of Whidbey Island, and throughout central and southern Puget Sound in Washington state. At each site (two in Whidbey Basin, five near the San Juan Islands, and three in southern Puget Sound) three shoreline types would be surveyed using a lampara net purse seine under 40m long designed to fish approximately four and a half meters deep. The minimally intrusive nature of the proposed activities and the fact that they would take place in the marine environment signify that they are very unlikely to have any measurable effects on adjacent areas.

Permit 25409 – The proposed work would take place in several unnamed channels adjacent to mainstems and tributary streams in to the following subbasins: Middle and Upper Willamette River, McKenzie River, Mollala-Pudding River, the Santiam River, and the Yamhill River. The minimally intrusive nature of the proposed activities (beach seining, minnow trapping, electrofishing), is such that we do not expect the work to have measurable downstream effects.

Permit 25463 – The proposed activities would take place throughout California. Fish sampling would occur in California's anadromous and non-anadromous water bodies (streams, rivers, lakes, reservoirs, bays, harbors, and coastal) using various methods of take that would be variably employed to minimize risk to (non-targeted) listed species.

Permit 25466 – The proposed activities would take place in Ulatis Project Flood Control channels in (mainly) channelized portions of Ulatis, New Alamo, Sweeney, Gibson, Canyon, Horse, and McCune creeks in the Lower Sacramento River, CA.

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The environmental baseline for this opinion is therefore the result of the impacts that many activities (summarized below and in the species' status sections) have had on the various listed species' survival and recovery. In many cases, the action area under consideration covers individual animals that could come from anywhere in the various listed species' entire ranges (see Sections 1.3 and 2.3). As a result, the effects of these past activities on the species themselves (that is, effects on abundance, productivity, etc.) cannot be tied to any particular population and are therefore displayed individually in the species status section summaries above (see Section 2.2).

Thus, for some of the work being contemplated here, the impacts that previous Federal, state, and private activities in the action area have had on the species are indistinguishable from those effects summarized below and in the previous section on the species' rangewide status. The same is true with respect to the species' habitat: for much of the contemplated work, the environmental baseline is the result of these activities' rangewide effects on the PBFs that are essential to the conservation of the species. However, as noted previously, some of the proposed work has a more limited geographic scope. If the work would not take place in marine or mainstem areas or would not be widely distributed across the majority of a given species' range, then the action area can be narrowed for a more specific analysis—and in those instances, the relevant local status information will be taken into account for both species and critical habitat.

Analysis at the ESU/DPS level will be performed for all permits listed in Table 1. The permits for which population-level analysis will be performed are:

- 15549-3R
- 15611-3R
- 18908-2R
- 19741-2R
- 23649-2M
- 24151

2.4.1 Summary for all Listed Species

2.4.1.1 Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids, rockfish, eulachon and sturgeon. NMFS' status reviews, Technical Recovery Team publications, and recovery plans for the listed species considered in this opinion identify several factors that have caused them to decline, as well as those that prevent them from recovering (many of which are the same). Very generally, these include harvest and hatchery practices and habitat degradation and curtailment caused by human development and resource extraction. NMFS' decisions to list the species identified a variety of factors that were limiting their recovery. None of these documents identifies scientific research as either a cause for decline or a factor preventing their recovery. See Tables 2 and 37 for summaries of the major factors limiting recovery of the listed species and how various factors have degraded PBFs and harmed listed species considered in this opinion. Also, please see section 2.2 for information regarding how climate change has affected and is affecting species and habitat in the action areas. Climate change was not generally considered a relevant factor when the species were listed and the critical habitat designated, but it is now.

As a general matter, all the species considered in this opinion have at least some biological requirements that are not being met in the action areas. The listed species are still experiencing the impact of a variety of past and ongoing Federal, state, and private activities in the action areas and that impact is expressed in the limiting factors described above and in the species status sections—all of which, in combination, are currently keeping the species from recovering and actively preventing them from having all their biological requirement met in the action area.

For detailed information on how various factors have degraded PBFs and harmed listed species, please see the references listed in the species and critical habitat status sections.

2.4.1.2 Research Effects

Although not identified as a factor for decline or a threat preventing recovery, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed salmonids—whether intentionally or not. For the year 2020, NMFS has issued numerous research section 10(a)(1)(A) scientific research permits allowing listed species to be taken and sometimes killed. NMFS has also issued numerous authorizations for state and tribal scientific research programs under ESA section 4(d). Table 38 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A).

Table 38. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2019.

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	849	33	3.951	0.154
		Listed Hatchery Intact Adipose	927	9	11.451	0.377
		Listed Hatchery Adipose Clip	1,141	59		
	Juvenile	Natural	386,621	8,554	12.221	0.270
		Listed Hatchery Intact Adipose	84,778	2,848	1.135	0.038
		Listed Hatchery Adipose Clip	206,220	10,892	0.435	0.023
Puget Sound Steelhead	Adult	Natural	1,814	39	9.611	0.236
		Listed Hatchery Intact Adipose	22	0		
		Listed Hatchery Adipose Clip	34	7		
	Juvenile	Natural	45,210	1,111	2.046	0.050
		Listed Hatchery Intact Adipose	1,796	28	1.596	0.025

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	4,752	101	4.320	0.092
Puget Sound/Georgia Basin DPS bocaccio[a]	Adult	Natural	38	21	2.301	1.042
	Subadult	Natural	2	1		
	Juvenile	Natural	66	26		
Puget Sound/Georgia Basin DPS yelloweye rockfish[a]	Adult	Natural	40	22	0.125	0.073
	Subadult	Natural	2	1		
	Juvenile	Natural	42	26		
Hood Canal summer-run chum salmon	Adult	Natural	2,007	31	7.981	0.123
	Juvenile	Natural	726,808	2,533	18.684	0.065
		Listed Hatchery Intact Adipose	135	3	0.090	0.002
Upper Columbia River spring-run Chinook salmon	Adult	Natural	223	6	7.765	0.209
		Listed Hatchery Intact Adipose	150	3	4.459	0.089
		Listed Hatchery Adipose Clip	168	7	2.698	0.112
	Juvenile	Natural	10,736	229	2.290	0.049
		Listed Hatchery Intact Adipose	1,024	33	0.278	0.009
		Listed Hatchery Adipose Clip	1,464	67	0.235	0.011
Upper Columbia River Steelhead	Adult	Natural	235	4	12.170	0.207
		Listed Hatchery Intact Adipose	94	2	8.083	0.172
		Listed Hatchery Adipose Clip	219	6	4.125	0.113
	Juvenile	Natural	32,221	662	16.161	0.332
		Listed Hatchery Intact Adipose	2,416	69	1.743	0.050
		Listed Hatchery Adipose Clip	10,332	248	1.503	0.036
Middle Columbia River Steelhead	Adult	Natural	1,432	20	28.345	0.396
		Listed Hatchery Intact Adipose	169	6	150.893	5.357
		Listed Hatchery Adipose Clip	933	12	208.259	2.679
	Juvenile	Natural	84,683	1,835	20.771	0.450

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Intact Adipose	9,180	132	8.310	0.119
		Listed Hatchery Adipose Clip	898	43	0.202	0.010
Snake River spring/summer-run Chinook salmon	Adult	Natural	1,907	15	14.901	0.117
		Listed Hatchery Intact Adipose	386	3	91.686	0.713
		Listed Hatchery Adipose Clip	1,256	9	52.618	0.377
	Juvenile	Natural	764,041	7,190	75.833	0.714
		Listed Hatchery Intact Adipose	45,827	424	5.911	0.055
		Listed Hatchery Adipose Clip	84,527	1,187	1.898	0.027
Snake River fall-run Chinook salmon	Adult	Natural	251	11	2.428	0.106
		Listed Hatchery Intact Adipose	213	2	1.572	0.015
		Listed Hatchery Adipose Clip	257	15	1.657	0.097
	Juvenile	Natural	1,978	112	0.286	0.016
		Listed Hatchery Intact Adipose	327	35	0.011	0.001
		Listed Hatchery Adipose Clip	816	139	0.033	0.006
Snake River Basin Steelhead	Adult	Natural	7,993	108	75.785	1.024
		Listed Hatchery Intact Adipose	2,279	36	14.123	0.223
		Listed Hatchery Adipose Clip	2,920	46	3.672	0.058
	Juvenile	Natural	290,245	3,669	36.356	0.460
		Listed Hatchery Intact Adipose	33,872	367	4.801	0.052
		Listed Hatchery Adipose Clip	78,737	909	2.386	0.028
Snake River sockeye salmon	Adult	Natural	11	4	2.015	0.733
		Listed Hatchery Adipose Clip	1	0	0.025	0.000
	Juvenile	Natural	10,578	462	55.148	2.409
		Listed Hatchery Adipose Clip	389	260	0.160	0.107
	Adult	Natural	275	14	0.933	0.048
		Listed Hatchery Intact Adipose	12	0	0.290	0.029

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	100	11		
Lower Columbia River Chinook salmon	Juvenile	Natural	768,119	10,584	6.540	0.090
		Listed Hatchery Intact Adipose	305	36	0.032	0.004
		Listed Hatchery Adipose Clip	53,837	1,564	0.172	0.005
Lower Columbia River coho salmon	Adult	Natural	823	12	2.756	0.040
		Listed Hatchery Intact Adipose	31	0	5.005	0.421
		Listed Hatchery Adipose Clip	409	37		
	Juvenile	Natural	180,018	2,551	27.215	0.386
		Listed Hatchery Intact Adipose	555	112	0.222	0.045
		Listed Hatchery Adipose Clip	53,486	1,855	0.734	0.025
Lower Columbia River Steelhead	Adult	Natural	1,794	21	13.885	0.163
		Listed Hatchery Adipose Clip	36	2	0.161	0.009
	Juvenile	Natural	68,505	1,175	19.454	0.334
		Listed Hatchery Intact Adipose	1	0	0.011	0.000
		Listed Hatchery Adipose Clip	40,944	615	3.420	0.051
Columbia River chum salmon	Adult	Natural	20	5	0.188	0.047
		Listed Hatchery Intact Adipose	1	0	0.235	0.000
	Juvenile	Natural	39,164	500	0.591	0.008
		Listed Hatchery Intact Adipose	562	18	0.093	0.003
Upper Willamette River Chinook salmon	Adult	Natural	206	6	2.019	0.059
		Listed Hatchery Adipose Clip	171	13	0.543	0.041
	Juvenile	Natural	44,252	695	3.652	0.057
		Listed Hatchery Intact Adipose	26	3	0.617	0.071
		Listed Hatchery Adipose Clip	8,680	277	0.184	0.006
Upper Willamette River Steelhead	Adult	Natural	227	4	7.795	0.137
	Juvenile	Natural	11,723	229	8.350	0.163

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Oregon Coast coho salmon	Adult	Natural	7,568	118	8.024	0.125
		Listed Hatchery Adipose Clip	21	4	3.757	0.716
	Juvenile	Natural	528,860	12,062	7.963	0.182
		Listed Hatchery Adipose Clip	284	20	0.473	0.033
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	1,626	17	17.937	0.188
		Listed Hatchery Intact Adipose	1,795	4	21.813	0.137
		Listed Hatchery Adipose Clip	590	11		
	Juvenile	Natural	149,104	1,857	7.405	0.092
		Listed Hatchery Intact Adipose	7,571	597	1.317	0.104
		Listed Hatchery Adipose Clip	3,938	64	1.969	0.032
Northern California Steelhead	Adult	Natural	725	17	10.040	0.235
	Juvenile	Natural	165,397	1,521	20.136	0.185
California Coastal Chinook salmon	Adult	Natural	475	15	6.753	0.213
	Juvenile	Natural	285,774	3,551	22.360	0.278
Sacramento River winter-run Chinook salmon	Adult	Natural	158	15	75.238	7.143
		Listed Hatchery Adipose Clip	183	45	8.199	2.016
	Juvenile	Natural	12,220	350	6.255	0.179
		Listed Hatchery Adipose Clip	8,595	1,562	4.298	0.781
Central Valley spring-run Chinook salmon	Adult	Natural	466	21	12.503	0.563
		Listed Hatchery Adipose Clip	578	59	25.429	2.596
	Juvenile	Natural	486,649	5,369	62.755	0.692
		Listed Hatchery Adipose Clip	17,939	3,136	0.827	0.145
California Central Valley Steelhead	Adult	Natural	3,106	60	184.223	3.559
		Listed Hatchery Adipose Clip	2,184	89	56.639	2.308
	Juvenile	Natural	28,846	630	4.576	0.100
		Listed Hatchery Adipose Clip	10,640	1,030	0.665	0.064

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central California Coast coho salmon	Adult	Natural	3,401	50	176.035	2.588
		Listed Hatchery Intact Adipose	1,650	33	504.587	10.092
	Juvenile	Natural	176,007	3,112	111.305	1.968
		Listed Hatchery Intact Adipose	84,390	1,953	50.874	1.177
Central California Coast Steelhead[c]	Adult	Natural	2,407	43	110.059	1.966
		Listed Hatchery Adipose Clip	487	12	12.597	0.310
	Juvenile	Natural	228,476	5,059	91.842	2.034
		Listed Hatchery Intact Adipose	6,200	124	-	-
		Listed Hatchery Adipose Clip	12,880	354	1.985	0.055
South-Central California Coast Steelhead	Adult	Natural	978	6	140.719	0.863
	Juvenile	Natural	17,398	218	22.007	0.276
Southern California Steelhead[b]	Adult	Natural	55	8	-	-
	Juvenile	Natural	21,490	583		
Southern DPS[a] Eulachon	Adult	Natural	33,551	31,047	0.109	0.102
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	480	452		
Southern DPS green sturgeon	Adult	Natural	464	12	22.032	0.570
	Subadult	Natural	81	6	0.733	0.054
	Juvenile	Natural	319	11	7.271	0.251
	Larvae	Natural	10	10	-	-

[a]Abundance for these species are only known for the adult life stage which is used to represent the entire DPS.

[b] We do not have any reliable abundance numbers for either adults or juveniles for this species.

c There are not reliable estimates of LHIA juveniles for this species, so the two hatchery components are combined.

Actual take levels associated with these activities are almost certain to be a substantially lower than the permitted levels. There are three reasons for this. First, most researchers do not handle the full number of juveniles or adults they are allowed. That is, for the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the allotted number of salmonids every year (20.45% of requested take and 14.74% of requested mortalities were used in ID, OR, and WA Section 10a1A permits from 2008 to 2017). Over the five-year period of 2014-2019, all section 10(a)(1)(A) permits active in California for ESA-listed steelhead and salmon resulted in only 8.8% of the requested handling (i.e., non-observation) take (489,389 of 5,575,092) and 3.6% of the requested mortalities (6,854 of 192,328). Second, we purposefully inflate our take and mortality estimates for each proposed study to account for the effects of potential accidental deaths. Therefore it is very likely that far fewer fish—especially juveniles—would be killed under any given research project than the researchers are permitted. Third, for salmonids, many of the fish that may be affected would be in the smolt stage. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, the estimates of percentages of ESUs/DPSs taken were derived by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed, and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of juvenile salmonids the research is likely to kill are undoubtedly smaller than the stated figures—probably something on the order of one seventh of the values given in the tables.

Also, as noted previously, the juvenile abundance numbers presented for each species should be viewed with caution because they only address one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate for species with no dam/passage counts is complicated by a host of variables, including the facts that: (1) the available data do not include all populations; (2) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (3) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (4) it is very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead; and (5) survival rates between life stages are poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.).

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

2.5.1 Effects on Critical Habitat

Full descriptions of effects of the proposed research activities are given in the following sections. In general, the permitted activities would be (1) electrofishing, (2) capturing fish with angling equipment, traps, weirs, and nets of various types, (3) collecting biological samples from live fish, and (4) collecting fish for biological sampling. All of these techniques are minimally intrusive in terms of their effect on habitat because they would involve very little, if any, disturbance of streambeds or adjacent riparian zones. Some fish collection activities could eventually involve bottom trawls in marine or estuarine environments which may temporarily disturb substrate, displace benthic invertebrate prey, and increase turbidity just above the water surface. However, such trawl actions affect small spatial areas of habitat that are not designated as "critical" and are brief in duration, so these effects are expected to be ephemeral and attenuate rapidly. Therefore none of the activities analyzed in this Opinion will measurably affect any habitat PBF function or value described earlier (see section 2.2.2).

2.5.2 Effects on the Species

As discussed above, the proposed research activities would not measurable affect any of the listed species' habitat. The actions are therefore not likely to measurably affect any of the listed species by reducing that habitat's ability to contribute to their survival and recovery.

The primary effect of the proposed research will be on the listed species in the form of capturing and handling the fish. Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, let alone entire species.

The following subsections describe the types of activities being proposed. Each is described in terms broad enough to apply to all the permits. The activities would be carried out by trained professionals using established protocols. The effects of the activities are well documented and discussed in detail below. No researcher would receive a permit unless the activities (e.g., electrofishing) incorporate NMFS' uniform, pre-established set of mitigation measures. These measures are described in Section 1.3 of this opinion. They are incorporated (where relevant) into every permit as part of the conditions to which a researcher must adhere.

Capture/handling

The primary effect of the proposed research on the listed species would be in the form of capturing and handling fish. We discuss effects from handling and anesthetizing fish, and the general effects of capture using seines and traps here. We discuss effects from other capture methods in more detail in the subsections below.

Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe et al. 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). The permit conditions identified in Section 1.3 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them, which makes them easy to capture. It can cause a suite of effects ranging from disturbing the fish to killing them. The percentage of fish that are unintentionally killed by electrofishing varies widely depending on the equipment used, the settings on the equipment, and the expertise of the technician (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Research indicates that using continuous direct current (DC) or low-frequency (30 Hz) pulsed DC waveforms produce lower spinal injury rates, particularly for salmonids (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Snyder 1995).

Most studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). Electrofishing can have severe effects on adult salmonids. Adult salmonids can be injured or killed due to spinal injuries that can result from forced muscle contractions. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study.

Spinal injury rates are substantially lower for juvenile fish than for adults. Smaller fish are subjected to a lower voltage gradient than larger fish (Sharber and Carothers 1988) and may, therefore, be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) reported a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin.

When using appropriate electrofishing protocols and equipment settings, shocked fish normally revive quickly. Studies on the long-term effects of electrofishing indicate that even with spinal injuries, salmonids can survive long-term; however, severely injured fish may have stunted growth (Dalbey et al. 1996, Ainslie et al. 1998).

Permit conditions would require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews:

- Use electrofishing only when other survey methods are not feasible.
- Be trained by qualified personnel in equipment handling, settings, maintenance to ensure proper operating condition, and safety.
- Conduct visual searches prior to electrofishing on each date and avoid electrofishing near adults or redds. If an adult or a redd is detected, researchers must stop electrofishing at the research site and conduct careful reconnaissance surveys prior to electrofishing at additional sites.
- Test water conductivity and keep voltage, pulse width, and rate at minimal effective levels. Use only DC waveforms.
- Work in teams of two or more technicians to increase both the number of fish seen at one time and the ability to identify larger fish without having to net them. Working in teams allows netter(s) to remove fish quickly from the electrical field and to net fish farther from the anode, where the risk of injury is lower.
- Observe fish for signs of stress and adjust electrofishing equipment to minimize stress.

- Provide immediate and adequate care to any fish that does not revive immediately upon removal from the electrical current.

The preceding discussion focused on the effects backpack electrofishing and the ways those effects would be mitigated. In larger streams and rivers, electrofishing units are sometimes mounted on boats or rafts. These units often use more current than backpack electrofishing equipment because they need to cover larger and deeper areas. The environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. As a result, boat electrofishing can have a greater impact on fish. Researchers conducting boat electrofishing must follow NMFS' electrofishing guidelines.

Gastric Lavage

Knowledge of the food and feeding habits of fish are important in the study of aquatic ecosystems. However, in the past, food habit studies required researchers to kill fish for stomach removal and examination. Consequently, several methods have been developed to remove stomach contents without injuring the fish. Most techniques use a rigid or semi-rigid tube to inject water into the stomach to flush out the contents.

Few assessments have been conducted regarding the mortality rates associated with nonlethal methods of examining fish stomach contents (Kamler and Pope 2001). However, Strange and Kennedy (1981) assessed the survival of salmonids subjected to stomach flushing and found no difference between stomach-flushed fish and control fish that were held for three to five days. In addition, when Light et al. (1983) flushed the stomachs of electrofished and anesthetized brook trout, survival was 100 percent for the entire observation period. In contrast, Meehan and Miller (1978) determined the survival rate of electrofished, anesthetized, and stomach-flushed wild and hatchery coho salmon over a 30-day period to be 87 percent and 84 percent respectively.

Hook and Line/Angling

Fish caught with hook and line and released alive may still die due to injuries and stress they experience during capture and handling. Angling-related mortality rates vary depending on the type of hook (barbed vs barbless), the type of bait (natural vs artificial), water temperature, anatomical hooking location, species, and the care with which fish are handled and released (level of air exposure and length of time for hook removal).

The available information assessing hook and release mortality of adult steelhead suggests that hook and release mortality with barbless hooks and artificial bait is low. Nelson et al. (2005) reported an average mortality of 3.6% for adult steelhead that were captured using barbless hooks and radio tagged in the Chilliwack River, BC. The authors also note that there was likely some tag loss and the actual mortality might be lower. Hooton (1987) found catch and release mortality of adult winter steelhead to average 3.4% (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait, and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1%. Natural bait had slightly higher mortality (5.6%) than did artificial lures (3.8%), and barbed hooks (7.3%) had higher mortality than barbless hooks (2.9%). Hooton (1987) concluded that catching and releasing adult steelhead was an effective mechanism for maintaining angling opportunity without negatively affecting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream at the same rate as steelhead not hooked and played to exhaustion. Pettit (1977) found that egg viability of hatchery steelhead was not negatively affected by catch-and-release of pre-spawning adult female steelhead. Bruesewitz (1995) found, on average, fewer than 13% of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8%) of critical area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Catch and release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on the catch and release mortality of steelhead in a California river, Taylor and Barnhart (1999) reported over 80% of the observed mortalities occurred at stream temperatures greater than 21 degrees C. Catch and release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Nelson et al. (2005) or Hooton (1987) because of warmer water and that fact that summer fish have an extended freshwater residence that makes them more likely to be caught. As a result, NOAA Fisheries expects steelhead hook and release mortality to be in the lower range discussed above.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized, stream-resident, rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of bait reduces juvenile steelhead mortality more than any other angling regulatory change. Artificial lures or flies tend to superficially hook fish, allowing expedited hook removal with minimal opportunity for damage to vital organs or tissue (Muoneke and Childress, 1994). Many studies have shown trout mortality to be higher when using bait than when angling with artificial lures and/or flies (Taylor and White 1992; Schill and Scarpella 1995; Muoneke and Childress 1994; Mongillo 1984; Wydoski 1977; Schisler and Bergersen 1996). Wydoski (1977) showed the average mortality of trout, when using bait, to be more than four times greater than the mortality associated with using artificial lures and flies. Taylor and White (1992) showed average mortality of trout to be 31.4% when using bait versus 4.9 and 3.8% for lures and flies, respectively. Schisler and Bergersen (1996) reported average mortality of trout caught on passively fished bait to be higher (32%) than mortality from actively fished bait (21%). Mortality of fish caught on artificial flies was only 3.9%. In the compendium of studies reviewed by Mongillo (1984), mortality of trout caught and released using artificial lures and single barbless hooks was often reported at less than 2%.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Huhn and Arlinghaus 2011; Bartholomew and Bohnsack 2005; Taylor and White 1992; Mongillo 1984; Wydoski 1977). Researchers have generally concluded that barbless hooks result in less tissue damage, they are easier to remove, and because they are easier to remove the handling time is shorter. In summary, catch-and-release mortality of steelhead is generally lowest when researchers are restricted to use of artificial flies and lures. As a result, all steelhead sampling via angling must be carried out using barbless artificial flies and lures.

Only a few reports are available that provide empirical evidence showing what the catch and release mortality is for Chinook salmon in freshwater. The ODFW has conducted studies of hooking mortality incidental to the recreational fishery for Chinook salmon in the Willamette River. A study of the recreational fishery estimates a per-capture hook-and-release mortality for wild spring Chinook salmon in Willamette River fisheries of 8.6% (Schroeder et al. 2000), which is similar to a mortality of 7.6% reported by Bendock and Alexandersdottir (1993) in the Kenai River, Alaska.

A second study on hooking mortality in the Willamette River, Oregon, involved a carefully controlled experimental fishery, and mortality was estimated at 12.2% (Lindsay et al. 2004). In hooking mortality studies, hooking location, gear type, and unhook time is important in determining the mortality of released fish. Fish hooked in the jaw or tongue suffered lower mortality (2.3 and 17.8% in Lindsay et al. (2004)) compared to fish hooked in the gills or esophagus (81.6 and 67.3%). Numerous studies have reported that deep hooking is more likely to result from using bait (e.g. eggs, prawns, or ghost shrimp) than lures (Lindsay et al. 2004). One theory is that bait tends to be passively fished and the fish is more likely to swallow bait than a lure. Passive angling techniques (e.g. drift fishing) are often associated with higher hooking mortality rates for salmon while active angling techniques (e.g. trolling) are often associated with lower hooking mortality rates (Cox-Rogers et al. 1999).

Catch and release fishing does not seem to have an effect on migration. Lindsay et al. (2004) noted, "hooked fish were recaptured at various sites at about the same frequency as control fish." Bendock and Alexandersdottir (1993) found that most of their tagged fish later turned up on the spawning grounds. Cowen et al. (2007) found little evidence of an adverse effect on spawning success for Chinook salmon.

Not all of the fish that are hooked are subsequently landed. We were unable to find any studies that measured the effect of hooking and losing a fish. However, it is reasonable to assume that nonlanded morality would be negligible, as fish lost off the hook are unlikely to be deeply hooked and would have little or no wound and bleeding (Cowen et al. 2007).

Based on the available data, the *U.S. v. Oregon* Technical Advisory Committee has adopted a 10% rate in order to make conservative estimates of incidental mortality in fisheries (TAC 2008). Nonetheless, given the fact that no ESA section 10 permit or 4(d) authorization may "operate to the disadvantage of the species," we allow no more than a three percent mortality rate for any listed species collected via angling, and all such activities must employ barbless artificial lures and flies.

Observation

For some parts of the proposed studies, listed fish would be observed but not captured (e.g., by snorkel surveys or from the banks). Observation without handling is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish—which are more sensitive to disturbance. During some of the research activities discussed below, redds may be visually inspected, but per NMFS' pre-established mitigation measures (included in state fisheries agency submittals), would not be walked on. Harassment is the primary form of take associated with these observation activities, and few if any injuries (and no deaths) are expected to occur—particularly in cases where the researchers observe from the stream banks rather than in the water. Because these effects are so small, there is little a researcher can do to mitigate them except to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves, and allow any disturbed fish the time they need to reach cover.

Rockfish barotrauma

Fish have two different types of swim bladders: physotome (open swim bladder) and physoclist (closed swim bladder). Physostome fish (such as salmonids) have a swim bladder connected to the esophagus via the pneumatic duct that allows them to gulp air to fill their swim bladder or quickly release the air when necessary. Physoclist fish (such as rockfish) lack the duct connection to the esophagus (Hallacher 1974) and are dependent upon passive gas exchange through their blood in the rete mirabile within their swim bladders (Alexander 1966). This allows them to become buoyant at much deeper depths than physotome fish, but they are unable to offload gases quickly during a rapid ascent.

For rockfish caught in waters deeper than 60 feet (18.3 m), the primary cause of injury and death is often barotrauma (NMFS 2017d). During rapid decompression, swim bladder gases expand exponentially which is further exacerbated by temperature increases. This results in swim bladder expansion; reduction in body cavity space; and displacement, eversion, and/or injury to the heart, kidneys, stomach, liver, and other internal organs (Rogers et al. 2008, Pribyl et al. 2009, Pribyl et al. 2011). Further, expanding gas can rupture and escape from the swim bladder filling the orbital space behind the eyes, stretching the optic nerve, and causing exophthalmia (Rogers et al. 2008). Once on the surface, rockfish can become positively buoyant, meaning they are unable to return to their previous water depth become susceptible to predation (Starr et al. 2002, Hannah et al. 2008, Jarvis and Lowe 2008).

Methods for reducing barotrauma impacts on rockfish include handling rockfish below the surface, decreasing handling time at the surface, and rapidly submerging them to their capture depth (Parker et al. 2006, Hannah and Matteson 2007, Hannah et al. 2008). Hannah et al. (2008) observed that rockfish that failed to submerge either (1) did not attempt to submerge or only made weak attempts to do so, or (2) vigorously attempted to submerge and failed, leading to his conclusion that buoyancy is not the sole cause of submergence failure. Starr et al. (2002) captured rockfish and brought them up to 20m below the surface (below the local thermocline) where divers surgically implanted sonic tags in rockfish, placed them in a recovery cage, and released them. Because they observed no mortalities or abnormal swimming when these methods were employed, Starr et al. (2002) deduced that reducing surface handling time appears to improve survivorship. Jarvis and Lowe (2008) noted a 78% survivorship rate after recompression for rockfish released within 10 minutes of landing, which increased to 83% when the fish were released within 2 minutes. Another method for increasing survival for captured rockfish involves rapidly submerging the rockfish after capture and handling. Though the rockfish do not avoid effects of barotrauma when handled in this manner, the immediate impacts of decompression will stop when they are returned to their capture depth. Hochhalter and Reed (2011) compared submergence success of yelloweye rockfish released at the surface and at depth in a mark-recapture study. Though 91% of the individuals showed external signs of barotrauma after capture, the 17-day survival rate was 98.8% after resubmergence, though survival was size-dependent. Yelloweye rockfish released at the surface successfully submerged only 22.1% of the time and had an unknown survivorship rate. In a different study, Hannah and Matteson (2007) researched nine different rockfish different species from six different sites off the Oregon coast. After being captured, rockfish were briefly handled (less than two minutes), placed in a release cage with a video camera, and returned to capture depth/neutral buoyancy. Release behavior was visually observed and scored for behavioral impairment. The behavioral effects of barotrauma appeared to be highly species-specific (probably due to anatomical differences among rockfish species) and health condition at the surface did not appear to be a good indicator of survivorship potential after recompression. In addition, barotrauma effects increase with capture depth.

Sacrifice (Intentionally Killing)

In some instances, it is necessary to kill a captured fish in order to gather whatever data a study is designed to produce. In such cases, determining effect is a very straightforward process: the sacrificed fish, if they are juveniles, are forever removed from the gene pool and the effect of their deaths is weighed in the context that the effect on their listed unit and, where possible, their local population. If the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed from the population, but so are all their potential progeny. Thus, killing pre-spawned adults has the greatest potential to affect the listed species. Because of this, NMFS only very rarely allows pre-spawned adults to be sacrificed. And, in almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery—thereby greatly decreasing the potential harm posed by sacrificing the adults. As a general rule, adults are not sacrificed for scientific purposes and no such activity is considered in this opinion.

Screw trapping

Smolt, rotary screw (and other out-migration) traps, are generally used to obtain information on natural population abundance and productivity. On average, they achieve a sample efficiency of four to 20% of the emigrating population from a river or stream--depending on river size. Although under some conditions traps may achieve a higher efficiency for a relatively short period of time (NMFS 2003b). Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured at rotary screw type traps to be one percent or less.

The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish. However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4 degrees F (18 degrees C) or if dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank.

The potential for unexpected injuries or mortalities among listed fish is reduced in a number of ways. These can be found in the individual study protocols and in the permit conditions stated earlier. In general, screw traps are checked at least daily and usually fish are handled in the morning. This ensures that the water temperature is at its daily minimum when fish are handled. Also, fish may not be handled if the water temperature exceeds 69.8 degrees Fahrenheit (21 degrees C). Great care must be taken when transferring fish from the trap to holding areas and the most benign methods available are used—often this means using sanctuary nets when transferring fish to holding containers to avoid potential injuries. The investigators' hands must be wet before and during fish handling. Appropriate anesthetics must be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and will be released only in slow water areas. And often, several other stringent criteria are applied on a case-by case basis: safety protocols vary by river velocity and trap placement, the number of times the traps are checked varies by water and air temperatures, the number of people working at a given site varies by the number of outmigrants expected, etc. All of these protocols and more are used to make sure the mortality rates stay at one percent or lower.

Tagging/Marking

Techniques such as Passive Integrated Transponder (PIT) tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore, any researchers engaged in such activities will follow the conditions listed previously in this Opinion (as well as any permit-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987; Jenkins and Smith 1990; Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically- or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Conner et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific Northwest salmon. The tag is injected into the nasal cartilage of a salmon and therefore causes little direct tissue damage (Bergman et al. 1968; Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon; however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead).

The other primary method for tagging fish is to implant them with acoustic tags, radio tags, or archival loggers. There are two main ways to accomplish this and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways.

The second method for implanting tags is to place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985; Mellas and Haynes 1985).

Fish with internal tags often die at higher rates than fish tagged by other means because tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. As with the other forms of tagging and marking, researchers will keep the harm caused by tagging to a minimum by following the conditions in the permits as well as any other permit-specific requirements.

Tissue Sampling

Tissue sampling techniques such as fin-clipping are common to many scientific research efforts using listed species. All sampling, handling, and clipping procedures have an inherent potential to stress, injure, or even kill the fish. This section discusses tissue sampling processes and its associated risks.

Fin clipping is the process of removing part or all of one or more fins to obtain non-lethal tissue samples and alter a fish's appearance (and thus make it identifiable). When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Marks can also be made by punching holes or cutting notches in fins, severing individual fin rays (Welch and Mills 1981), or removing single prominent fin rays (Kohlhorst 1979). Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (e.g., Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly—especially those caused by partial clips.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it and Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100% recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are clipped. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality, but other studies have been less conclusive.

Trawls

Trawls are cone-shaped, mesh nets that are towed, often, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the codend of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. However, all of the trawling considered in this opinion is midwater trawling which may be less likely to capture heavy debris loads than benthic or demersal trawl sampling. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Stickney 1983, Hayes et al. 1996).

Weirs

Capture of adult salmonids by weirs is common practice in order to collect information; (1) enumerate adult salmon and steelhead entering the watershed; (2) determine the run timing of adult salmon and steelhead entering the watershed; (3) estimate the age, sex and length composition of the salmon escapement into the watershed; and (4) used to determine the genetic composition of fish passing through the weir (i.e. hatchery versus natural). Information pertaining to the run size, timing, age, sex and genetic composition of salmon and steelhead returning to the respective watershed will provide managers valuable information to refine existing management strategies.

Some weirs have a trap to capture fish, while other weirs have a video or DIDSON sonar to record fish migrating through the weir. Weirs with or without a trap, have the potential to delay migration. All weir projects will adhere to the draft NMFS West Coast Region Weir Guidelines and have included detailed descriptions of the weirs. The Weir Guidelines require the following: (1) traps must be checked and emptied daily, (2) all weirs including video and DIDSON sonar weirs must be inspected and cleaned of any debris daily, (3) the development and implementation of monitoring plans to assess passage delay, and (4) a development and implementation of a weir operating plan. These guidelines are intended to help improve fish weir design and operation in ways which will limit fish passage delays and increase weir efficiency.

2.5.3 Species-specific Effects of Each Permit

In previous sections, we estimated the annual abundance of adult and juvenile listed salmonids, eulachon, green sturgeon, and rockfish. Since there are no measurable habitat effects, the analysis will consist primarily of examining directly measurable impacts of proposed activities on abundance. Abundance effects are themselves relevant to extinction risk, are directly related to productivity effects, and are somewhat but less directly to structure and diversity effects. Examining the magnitude of these effects at the individual and, where possible, population levels is the best way to determine effects at the species level. Table 39 displays the estimated annual abundance of the listed species.

The analysis process relies on multiple sources of data. In Section 2.2.1 (Status of the Species), we estimated the average annual abundance for the species considered in this document. For most of the listed species, we estimated abundance for adult returning fish and outmigrating smolts. These data come from estimates compiled by our Science Centers for the species status reviews, which are updated every five years. Additional data sources include state agencies (i.e., CDFW, IDFW, ODFW, and WDFW), county and local agencies, and educational and non-profit institutions. These sources are vetted for scientific accuracy before their use. For hatchery propagated juvenile salmonids, we use hatchery production goals. Table 39 displays the estimated annual abundance of hatchery-propagated and naturally produced listed fish.

In conducting the following analyses, we have tied the effects of each proposed action to its impacts on individual populations (or population groups) wherever it was possible to do so. In those instances, the status of the local population will be discussed and taken into account. In other instances, the nature of the project (i.e., it is broadly distributed or situated in mainstem habitat) is such that the take cannot reliably be assigned to any population or group of populations. In those cases, the effects of the action are measured in terms of how they are expected to affect each listed unit's total abundance by origin (Natural) and production (Listed Hatchery Adipose Clip and Listed Hatchery Intact Adipose)—rather than at the population scale. Table 39 displays the estimated annual abundance of the listed species.

Table 39. Estimated annual abundance of ESA listed fish.

Species	Life Stage	Origin	Abundance
Puget Sound Chinook salmon	Adult	Natural	21,486
		Listed Hatchery, Clipped and Intact	18,060
	Juvenile	Natural	3,163,652
		Listed Hatchery Intact Adipose	7,470,630
		Listed Hatchery Adipose Clip	47,372,500
Puget Sound Steelhead	Adult	Listed Hatchery and Natural Origin	19,456
	Juvenile	Natural	2,210,140
		Listed Hatchery Intact Adipose	112,500
		Listed Hatchery Adipose Clip	110,000
Puget Sound/Georgia Basin DPS bocaccio	Adult	Natural	4,606
Puget Sound/Georgia Basin DPS yelloweye rockfish	Adult	Natural	66,998
Hood Canal summer-run chum salmon	Adult	Natural	25,146
		Listed Hatchery Intact Adipose	1,452
	Juvenile	Natural	3,889,955
		Listed Hatchery Intact Adipose	150,000
Upper Columbia River spring-run Chinook salmon	Adult	Natural	2,872
		Listed Hatchery Intact Adipose	3,364
		Listed Hatchery Adipose Clip	6,226
	Juvenile	Natural	468,820

Species	Life Stage	Origin	Abundance
		Listed Hatchery Intact Adipose	368,642
		Listed Hatchery Adipose Clip	621,759
Upper Columbia River Steelhead	Adult	Natural	1,931
		Listed Hatchery Intact Adipose	1,163
		Listed Hatchery Adipose Clip	5,309
	Juvenile	Natural	199,380
		Listed Hatchery Intact Adipose	138,601
		Listed Hatchery Adipose Clip	687,567
Middle Columbia River Steelhead	Adult	Natural	5,052
		Listed Hatchery Intact Adipose	112
		Listed Hatchery Adipose Clip	448
	Juvenile	Natural	407,697
		Listed Hatchery Intact Adipose	110,469
		Listed Hatchery Adipose Clip	444,973
Snake River spring/summer-run Chinook salmon	Adult	Natural	12,798
		Listed Hatchery Intact Adipose	421
		Listed Hatchery Adipose Clip	2,387
	Juvenile	Natural	1,007,526
		Listed Hatchery Intact Adipose	775,305
		Listed Hatchery Adipose Clip	4,453,663
Snake River fall-run Chinook salmon	Adult	Natural	10,337
		Listed Hatchery Intact Adipose	13,551
		Listed Hatchery Adipose Clip	15,508
	Juvenile	Natural	692,819
		Listed Hatchery Intact Adipose	2,862,418
		Listed Hatchery Adipose Clip	2,483,713

Species	Life Stage	Origin	Abundance
Snake River Basin Steelhead	Adult	Natural	10,547
		Listed Hatchery Intact Adipose	16,137
		Listed Hatchery Adipose Clip	79,510
	Juvenile	Natural	798,341
		Listed Hatchery Intact Adipose	705,490
		Listed Hatchery Adipose Clip	3,300,152
Snake River sockeye salmon	Adult	Natural	546
		Listed Hatchery Adipose Clip	4,004
	Juvenile	Natural	19,181
		Listed Hatchery Adipose Clip	242,610
Lower Columbia River Chinook salmon	Adult	Natural	29,469
		Listed Hatchery, Clipped and Intact	38,594
	Juvenile	Natural	11,745,027
		Listed Hatchery Intact Adipose	962,458
		Listed Hatchery Adipose Clip	31,353,395
Lower Columbia River coho salmon	Adult	Natural	29,866
		Listed Hatchery, Clipped and Intact	8,791
	Juvenile	Natural	661,468
		Listed Hatchery Intact Adipose	249,784
		Listed Hatchery Adipose Clip	7,287,647
Lower Columbia River Steelhead	Adult	Natural	12,920
		Listed Hatchery, Clipped and Intact	22,297
	Juvenile	Natural	352,146
		Listed Hatchery Intact Adipose	9,138
		Listed Hatchery Adipose Clip	1,197,156
Columbia River chum salmon	Adult	Natural	10,644

Species	Life Stage	Origin	Abundance
		Listed Hatchery Intact Adipose	426
	Juvenile	Natural	6,626,218
		Listed Hatchery Intact Adipose	601,503
Upper Willamette River Chinook salmon	Adult	Natural	10,203
		Listed Hatchery, Clipped and Intact	31,476
	Juvenile	Natural	1,211,863
		Listed Hatchery Intact Adipose	4,214
		Listed Hatchery Adipose Clip	4,709,045
Upper Willamette River Steelhead	Adult	Natural	2,912
	Juvenile	Natural	140,396
Oregon Coast coho salmon	Adult	Natural	94,320
		Listed Hatchery Adipose Clip	559
	Juvenile	Natural	6,641,564
		Listed Hatchery Adipose Clip	60,000
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	9,065
		Listed Hatchery, Clipped and Intact	10,934
	Juvenile	Natural	2,013,593
		Listed Hatchery Intact Adipose	575,000
		Listed Hatchery Adipose Clip	200,000
Northern California Steelhead	Adult	Natural	7,221
	Juvenile	Natural	821,389
California Coastal Chinook salmon	Adult	Natural	7,034
	Juvenile	Natural	1,278,078
Sacramento River winter-run Chinook salmon	Adult	Natural	210
		Listed Hatchery Adipose Clip	2,232
	Juvenile	Natural	195,354

Species	Life Stage	Origin	Abundance
		Listed Hatchery Adipose Clip	200,000
Central Valley spring-run Chinook salmon	Adult	Natural	3,727
		Listed Hatchery Adipose Clip	2,273
	Juvenile	Natural	775,474
		Listed Hatchery Adipose Clip	2,169,329
California Central Valley Steelhead	Adult	Natural	1,686
		Listed Hatchery Adipose Clip	3,856
	Juvenile	Natural	630,403
		Listed Hatchery Adipose Clip	1,600,653
Central California Coast coho salmon	Adult	Natural	1,932
		Listed Hatchery Intact Adipose	327
	Juvenile	Natural	158,130
		Listed Hatchery Intact Adipose	165,880
Central California Coast Steelhead	Adult	Natural	2,187
		Listed Hatchery Adipose Clip	3,866
	Juvenile	Natural	248,771
		Listed Hatchery Adipose Clip	648,891
South-Central California Coast Steelhead	Adult	Natural	695
	Juvenile	Natural	79,057
Southern California Steelhead*	-	-	-
Southern DPS Eulachon	Adult	Natural	32,029,043
Southern DPS green sturgeon	Adult	Natural	2,106
	Subadult	Natural	11,055
	Juvenile	Natural	4,387

* We have no reliable abundance estimates for this species.

Permit 1415-5R

Under permit 1415-5R the U.S. Fish and Wildlife Service's Red Bluff Office would be renewing a permit that since 2014 has authorized them to take juvenile and adult SacR winter-run and CVS Chinook salmon, adult and juvenile CCV steelhead, and juvenile SDPS green sturgeon for nine studies: (1) Battle Creek Fish Community Structure Evaluation (Pre/Post-Restoration), (2) Battle Creek Juvenile Salmonid Monitoring Project, (3) Battle Creek Adult Salmonid Monitoring Project, (4) Battle Creek emergence trapping, (5) Clear Creek Juvenile Salmonid Monitoring Project, (6) Clear Creek Fish Restoration Program Monitoring, (7) Sacramento River Juvenile Fish Monitoring at Red Bluff Diversion Dam (RBDD), (8) Life History Studies on the Sacramento River SDPS green sturgeon, and (9) Sacramento River Winter Chinook Salmon Carcass Survey.

Under these nine studies, juvenile salmon would be observed via snorkel surveys and captured using backpack electrofishing equipment, rotary screw traps, emergence traps, trammel nets, and beach seines. In addition, juvenile salmon would be handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample of captured those fish may be anesthetized, tissue sampled and PIT-tagged prior to release. A small number of juvenile CVS Chinook and CCV steelhead (100 of each) would be sacrificed for otolith sampling and analysis. Adult salmon would be observed via snorkel surveys or spawning surveys and captured using beach seines and fish weirs. Tissues would be collected from any carcasses encountered during snorkel surveys. Juvenile green sturgeon would be captured (benthic trawls, trammel or gill nets), anesthetized, tissue sampled and tagged (PIT or acoustic). Larval green sturgeon would be captured using fyke nets. The same procedures described above would be performed on larvae captured with fyke nets (tagging would be dependent on size). Egg Mats would be used to sample green sturgeon larvae and eggs (eggs and larvae would be sacrificed). With the exception of the juvenile salmon otolith research (above), the researchers are not proposing to kill any of the fish being captured, but a small number of fish may be killed as an inadvertent result of these activities. The amount of take the USFWS is requesting is found in the table below.

Table 40. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 1415-5R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release, O=observe, D=Dead animal, IM= Intentional mortality.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/H/R	102	0	48.571	0.000
		Natural	C/M, T, ST/R	1,000	0	476.190	0.000
		Natural	C,S,T	200	5	95.238	2.381

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/H/R	102	0	4.570	0.000
		Listed Hatchery Adipose Clip	C,S,T	200	5	8.961	0.224
		Listed Hatchery Adipose Clip	C/M, T, ST/R	1,000	0	44.803	0.000
	Spawned Adult/ Carcass	Natural	O/ST D	10,010	0	-	-
		Listed Hatchery Adipose Clip	O/ST D	1,800	0		
	Juvenile	Natural	C/H/R	61,550	655	31.507	0.335
		Natural	IM	160	160	0.082	0.082
		Natural	C/M, T, ST/R	354,550	10,340	181.491	5.293
		Listed Hatchery Adipose Clip	C/M, T, ST/R	195,000	5,850	97.500	2.925
		Listed Hatchery Adipose Clip	C/H/R	1,450	50	0.725	0.025
Central Valley spring-run Chinook salmon	Adult						
		Natural	O/ST D	320	0	8.586	0.000
		Natural	C/H/R	122	1	3.273	0.027
		Natural	C/M, T, ST/R	850	0	22.807	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	IM	20	20	0.880	0.880
	Spawned Adult/ Carcass	Natural	O/ST D	1,327	0	-	-
	Juvenile	Natural	C/H/R	142,200	4,350	18.337	0.561
		Natural	C/M, T, ST/R	247,950	7,282	31.974	0.939
		Natural	IM	125	125	0.016	0.016
California Central Valley Steelhead	Adult	Natural	C/H/R	602	30	35.706	1.779
		Natural	C/M, T, ST/R	209	2	12.396	0.119
		Listed Hatchery Adipose Clip	C/H/R	50	0	1.297	0.000
	Spawned Adult/ Carcass	Natural	O/ST D	50	0	-	-
	Juvenile	Natural	C/H/R	27,525	870	4.366	0.138
		Natural	C/M, T, ST/R	8,000	255	1.269	0.040
		Natural	IM	150	150	0.024	0.024
		Listed Hatchery Adipose Clip	C,S,T	10,000	500	0.625	0.031
		Listed Hatchery Adipose Clip	C/H/R	5,100	150	0.319	0.009

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/M, T, ST/R	200	10	0.012	<0.001
Southern DPS green sturgeon	Juvenile	Natural	C/M, T, ST/R	1,200	60	27.354	1.368
	Larvae	Natural	C/M, T, ST/R	11,000	1,000	-	-
	Egg	Natural	IM	1,250	1,250		

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, for most species the researchers would take a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area of the Sacramento River including Clear and Battle Creeks, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

In cases where the fraction of the ESU or DPS potentially killed is >0.5% the absolute number of adults requested is small, but these appear as large percentages because our current estimates of adult abundance are also low. These abundance estimates are likely an underestimates because they don't include populations for which we have no data and assume the lowest conservative figures determined to be reliable. Moreover, this proposed research is intended, in part, to provide more accurate estimates.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. A great deal of the information we have on SacR winter-run, CVS Chinook salmon, CCV steelhead, and juvenile SDPS green sturgeon in the Sacramento River comes directly from previous iterations of this research. And it is possible that the impacts could be even smaller than those laid out above. In fact, over the past five years, the researchers have only taken 3.44% of their requested take and killed 4.63% of the requested mortalities, so it is most likely that the actual effect will be less than one-twentieth of that displayed.

Permit 1440-3R

Under permit 1440-3R the IEP would be renewing a permit that since 2003 has authorized them to take adult and juvenile SacR winter-run and CVS Chinook salmon, CV and CCC steelhead, and SDPS green sturgeon for eleven studies: (1) The Adult Striped Bass Tagging Study, (2) The Fall Midwater Trawl Survey, (3) The adult Sturgeon Population Tagging Study, (4) The Summer Tow-net pelagic fish survey, (5) The San Francisco Bay Study freshwater outflow study, (6) The 20-mm post-larval and juvenile Delta Smelt survey, (7) The Yolo Bypass Fish Monitoring Program, (8) The Zooplankton Study, (9) The Spring Kodiak Trawl Survey, (10) The Suisun Marsh Salinity Survey, (11) The Smelt Larva Survey.

Under the various projects juvenile salmon would be captured (via fyke nets, gill nets, midwater trawls, trammel nets, hoop nets, otter trawls, larval fish nets, zooplankton nets, Kodiak trawl nets, rotatory screw traps, and beach seine), handled, and released. A small subset of the juvenile fish would be captured, anesthetized, measured, weighed, tagged, tissue sampled, and released. Adult salmon would be captured (via fyke nets, midwater trawls, trammel nets, hoop nets, otter trawls, Kodiak trawl nets, and beach seines), handled, and released. A small subset of adult salmon would be captured, anesthetized, measured, weighed, tagged, tissue sampled and released. Under three of the projects (Studies 5, 7, and 9) some adipose-clipped, artificially propagated juvenile spring- and winter-run Chinook salmon would intentionally be sacrificed to collect coded wire tags (the data from which would be used for management purposes). In addition, adult green sturgeon would be captured (fyke net, trammel net, midwater trawl, otter trawl), handled, and released. A subset of juvenile and adult greens sturgeon would be captured, anesthetized, measured, weighed, tagged, tissue sampled, and released. With the exception of the directed mortality of adipose-clipped juvenile salmon (above), the researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 41. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 1440-3R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release, IM= Intentional mortality.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/H/R	28	1	13.333	0.476
		Natural	C/M, T, ST/R	11	1	5.238	0.476
		Listed Hatchery Adipose Clip	C/H/R	15	1	0.672	0.045

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/M, T, ST/R	3	0	0.134	0.000
	Juvenile	Natural	C/H/R	71	9	0.036	0.005
		Natural	C/M, T, ST/R	58	3	0.030	0.002
		Listed Hatchery Adipose Clip	C/H/R	35	4	0.017	0.002
		Listed Hatchery Adipose Clip	IM	76	76	0.038	0.038
Central Valley spring-run Chinook salmon	Adult	Natural	C/H/R	95	2	2.549	0.054
		Natural	C/M, T, ST/R	12	1	0.322	0.027
		Listed Hatchery Adipose Clip	C/H/R	49	1	2.156	0.044
		Listed Hatchery Adipose Clip	C/M, T, ST/R	6	0	0.264	0.000
	Juvenile	Natural	C/H/R	339	13	0.044	0.002
		Natural	C/M, T, ST/R	570	20	0.074	0.003
		Listed Hatchery Adipose Clip	C/H/R	36	4	0.002	<0.001
		Listed Hatchery Adipose Clip	IM	226	226	0.010	0.010

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
California Central Valley Steelhead	Adult	Natural	C/H/R	35	3	2.076	0.178
		Listed Hatchery Adipose Clip	C/H/R	19	1	0.493	0.026
	Juvenile	Natural	C/H/R	92	8	0.015	0.001
		Listed Hatchery Adipose Clip	C/H/R	108	9	0.007	<0.001
Central California Coast Steelhead	Adult	Natural	C/H/R	1	0	0.046	0.000
	Juvenile	Natural	C/H/R	3	1	0.001	<0.001
Southern DPS green sturgeon	Adult	Natural	C/H/R	17	0	0.807	0.000
		Natural	C/M, T, ST/R	20	1	0.950	0.047
	Juvenile	Natural	C/H/R	77	1	1.755	0.023
		Natural	C/M, T, ST/R	130	1	2.963	0.023

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area throughout the San Francisco Bay-Delta region, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. Moreover, it is very likely that the impacts could be even smaller than those laid out above. In fact, over the past five years, the researchers have only taken 8.91% of their requested take and killed 10.07% of the requested mortalities.

Permit 13675-3R

Under permit 13675-3R the Fishery Foundation of California would be renewing a permit that since 2010 has authorized them to take juvenile SacR winter-run and CVS Chinook salmon, juvenile CV steelhead, and juvenile SDPS green sturgeon to evaluate salmon presence and habitat in flood plain areas. Under the permit juvenile salmon and green sturgeon would be captured with beach seines and fyke nets, handled, and released. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 42. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 13675-3R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Juvenile	Natural	C/H/R	60	1	0.031	<0.001
		Listed Hatchery Adipose Clip	C/H/R	60	1	0.030	
Central Valley spring-run Chinook salmon	Juvenile	Natural	C/H/R	575	11	0.074	0.001
		Listed Hatchery Adipose Clip	C/H/R	215	3	0.010	<0.001
California Central Valley Steelhead	Juvenile	Natural	C/H/R	30	1	0.005	<0.001
		Listed Hatchery Adipose Clip	C/H/R	29	1	0.002	<0.001
Southern DPS green sturgeon	Juvenile	Natural	C/H/R	2	0	0.046	0.000

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take a very small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area throughout the Sacramento River basin, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. Moreover, it is very likely that the impacts could be even smaller than those laid out above. In fact, over the past five years, the researchers have only taken 3.56% of their requested take and killed 1.11% of the requested mortalities—so the actual effect could really be on the order of one one-hundredth of that displayed.

Permit 15486-3R

As noted previously, West Fork Environmental is seeking to renew a permit that currently allows them to capture and handle juvenile LCR Chinook, LCR steelhead, LCR coho, UWR steelhead, and OC coho during the course of headwater stream surveys over wide parts of Washington and Oregon. Under the renewed permit, the researchers would also capture small numbers of fish from Idaho and Eastern and Western Washington (see below for species). The researchers would use backpack electrofishing equipment capture the fish and would then release them without tagging or even handling more than is necessary to ensure that they have recovered from the effects of being captured. The researchers are requesting the following amounts of take:

Table 43. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 15486-3R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Steelhead	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
Upper Columbia River spring-run Chinook salmon	Juvenile	Natural	C/H/R	10	1	0.002	<0.001
Upper Columbia River Steelhead	Juvenile	Natural	C/H/R	10	1	0.005	<0.001
Middle Columbia River Steelhead	Juvenile	Natural	C/H/R	10	1	0.002	<0.001
Snake River spring/summer-run Chinook salmon	Juvenile	Natural	C/H/R	20	2	0.002	<0.001
Snake River fall-run Chinook salmon	Juvenile	Natural	C/H/R	20	2	0.003	<0.001
Snake River Basin Steelhead	Juvenile	Natural	C/H/R	20	2	0.003	<0.001
Lower Columbia River Chinook salmon	Juvenile	Natural	C/H/R	20	1	<0.001	<0.001
Lower Columbia River coho salmon	Juvenile	Natural	C/H/R	20	1	0.003	<0.001
Lower Columbia River Steelhead	Juvenile	Natural	C/H/R	20	1	0.006	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Willamette River Chinook salmon	Juvenile	Natural	C/H/R	20	1	0.002	<0.001
Upper Willamette River Steelhead	Juvenile	Natural	C/H/R	20	1	0.014	<0.001
Oregon Coast coho salmon	Juvenile	Natural	C/H/R	20	2	<0.001	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

The permitted activities may thus unintentionally cause the death of a very small number of juvenile fish. The permitted activities may kill no more than 0.001% of the expected abundance for any of the listed salmon or steelhead. Moreover, that take (and any of its potential impacts) would be spread out over tributary habitat in Idaho, Eastern Oregon and Washington, Western Oregon and Washington, and the Oregon coast. Thus, no population is likely to experience a disproportionate amount of even these small losses. As a result, the activities are likely to have only a minimal impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity. And that miniscule effect is likely to be even more minimal than displayed because over the last ten years, West Fork Environmental researchers have generally not killed any of the fish they were allotted—and they have killed none in the last five years.

An effect of the research that cannot be quantified is the benefit to the species' conservation resulting from the research. The purpose of the research is to provide owners of industrial forest lands and the major state lands managers in Washington and Oregon with accurate maps of where threatened and endangered salmonids are found on state and industrial forest lands. The work would benefit the salmon and steelhead by helping land managers plan and carry out their activities in ways that would have the smallest possible effect on the listed fish.

Permit 15549-3R

Under the renewed Permit 15549, the CRITFC researchers would continue to use rotary screw traps and backpack electrofishing equipment to capture juvenile MCR steelhead. Once captured, the fish would be variously handled, measured, tagged (with PIT tags), tissue sampled, and released. The research would take place in Satus, Toppenish, Ahtanum, and Naches Creeks, Washington. All traps would be monitored—continuously if necessary—to ensure that fish are not harmed by debris entrainment or any other hazard associated with screw-trapping operations. The researchers would also cease operations at high flows and, when circumstances dictate (e.g., flow conditions): trapping efficiency would become a secondary consideration to the needs of the fish and traps would be moved to a portion of the stream considered safer for the fish.

The captured fish would be anesthetized (with MS-222), processed rapidly in small lots, allowed to recover for at least fifteen minutes in buckets of aerated water, and released at their capture site when they are seen to be swimming normally. Most of the fish would receive PIT tags and have a scale removed for tissue analysis. A few tagged fish would be moved upstream and released to determine trap efficiency. NMFS' electrofishing guidelines will be followed at all times when the researchers employ that type of equipment. Fish captured by backpack electrofishing would be handled in much the same way as the fish captured by screw trap: they would be tissue sampled and tagged (but at a lower rate than the screw-trapped fish) and released at the point of capture once they have recovered from the anesthetic. The researchers are requesting to take the following numbers of MCR steelhead:

Table 44. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 15549-3R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River Steelhead	Juvenile	Natural	C/H/R	200	8	0.049	0.002
		Natural	C/M, T, ST/R	9,350	284	2.293	0.070

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

This signifies that the research, in total, would kill at most 0.07% of the wild component of the outmigration and 0.03% of the species' outmigration as whole. These effects are very small but they would in fact be magnified by the fact that the losses would be concentrated on only a portion of the outmigrating MCR steelhead smolts—in fact, they would all come from the Yakima River major population group (MPG), which produces roughly 11% of the total fish in the DPS and a somewhat larger fraction of the wild fish (NMFS 2009). This means that, conservatively speaking, the effects on the Yakima MPG would approach something on the order of 0.7% mortality for the natural juveniles coming out of that system. This represents a small effect on the MPG's abundance—

roughly seven fish in every thousand in the Yakima MPG may (at worst) be killed by the planned research. But that minor effect on abundance (and therefore productivity) is small enough that it cannot reliably be resolved with respect to any impact it may have on diversity or population structure. Moreover, it is very likely that the losses would not even be as large as that 0.7% figure. In the last ten years CRITFC has been running this research program, they have never reached, let alone exceeded, the amounts of take they have previously been allotted. In fact, over the past five years the researchers have taken 30.54% of their requested total take and killed 16.37% of the requested mortalities. Given that history, we anticipate that this will continue to be the case, and the actual effect of the operation will be approximately 80% lower than that displayed.

An effect of the research that cannot be quantified is the benefit to the species' conservation resulting from the research. The purpose of the research is to provide tribal and Federal managers with the most resent status information for the species and data on fish movement and presence in the Yakima subbasin. The work would benefit the salmon and steelhead by helping managers coordinate, plan, and carry out recovery activities.

Permit 15611-3R

Under the renewed permit 15611, WDFW would continue to trap adult LCR Chinook salmon, LCR steelhead, LCR coho salmon, and CR chum salmon below the Mt. St. Helens sediment retention dam on the North Fork Toutle River, put them in trucks, and transport them to spawning habitat above the structure. The Washington Department of Fish and Wildlife proposes to operate the trap several days a week during the species' upstream migration. Naturally produced salmon and steelhead would be anesthetized, and variously marked, tissue sampled, and scale sampled before being transported. No trapped hatchery fish would transported, instead they would be released below the sediment retention structure. The following table displays the amounts of take being requested.

Table 45. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 15611-3R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Lower Columbia River Chinook salmon	Adult	Natural	C,S,T	50	2	0.170	0.007
		Listed Hatchery Adipose Clip	C/M, T, ST/R	50	2	0.130	0.005
Lower Columbia River coho salmon	Adult	Natural	C,S,T	600	6	2.009	0.020
		Listed Hatchery Adipose Clip	C/M, T, ST/R	200	4	2.275	0.046

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Lower Columbia River Steelhead	Adult	Natural	C,S,T	1,040	11	8.050	0.085
		Listed Hatchery Adipose Clip	C/M, T, ST/R	50	2	0.224	0.009
Columbia River chum salmon	Adult	Natural	C,S,T	20	1	0.188	0.009

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

This signifies that the research, in total, would kill at most 0.085% of the wild component of any species' adult returns (LCR steelhead)—all the other species' components would experience effects on the order of one-half to one-tenth that magnitude. These effects are very small, but they would be magnified by the fact that the losses would be concentrated on only a portion of the adult returns.

It is difficult to predict the number of fish that will return to the North Fork Toutle River. WDFW's records from the trap indicate the abundance for wild steelhead and coho can fluctuate from fewer than one hundred to several hundred adult spawners (Table 46). Furthermore, WDFW believes the abundance of steelhead and coho could increase in the future based on the facts that they are now using several release sites in the spawning habitat and the trap efficiency has improved in recent years.

Table 46. Trap counts and number of wild fish released above the Mt. St. Helens sediment retention structure (Pers. Comm. Chris Gleizes, WDFW, 1/14/2016).

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wild Winter Steelhead	410	249	166	300	155	96	89	258	170	207	114	277	618
Hatchery Winter Steelhead	3	15	1	5	0	0	0	18	10	16	6	15	25
Wild Summer Steelhead	7	4	6	3	3	3	0	3	0	2	2	6	13

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hatchery Summer Steelhead	10	43	12	5	1	0	6	18	4	7	10	10	16
Wild Coho	443	303	215	229	277	115	254	206	58	150	386	115	92
Hatchery Coho	190	13	57	78	29	17	113	58	1	0	10	9	

As the above table illustrates, the potential mortality of salmon and steelhead in the Toutle River basin could be range from less than 1% to nearly 8% of the local populations. However, we set the take levels high to allow for the natural fluctuation in abundance and the actual mortality would likely be much lower. To allow for the unexpected mortality of some fish we include a minimum of two mortalities per species and production type. However, given the fact that over the past five years the researchers have taken only 20.88% of their requested total take and killed 0.71% of the requested mortalities, it is very likely that the actual effect will be a great deal smaller than that displayed.

Moreover, the North Fork Toutle does not have a historically independent summer steelhead population—the North Toutle hatchery releases summer steelhead that are from the Skamania Hatchery stock—so any wild summer steelhead in the Toutle River could well be the progeny of hatchery fish spawning in the wild. We also note that no chum salmon have ever been captured at the fish collection facility. Recent efforts to recover chum salmon have resulted in an increase in the number of naturally produced fish returning to the lower Columbia River. Therefore, we include a few chum salmon in the analysis.

Thus, the trap and haul operation and associated research activities could possibly have a small local impact on abundance and productivity, but no appreciable impact on structure or diversity. And even that small effect would be offset to some degree by the fact that the trap and haul operation is the sole reason there are still any salmon and steelhead populations in the North Fork Toutle River.

Permit 16274-2R

Under Permit 16274-2R, the Mendocino Redwood Company would be renewing a permit that since 1991 has authorized them to take adult and juvenile CCC Chinook, CCC steelhead, SONCC coho, and CCC coho salmon to assess juvenile and adult distribution and population structure in streams on MRC's property.

Under this permit, adult fish would be observed and tissue samples would be collected from carcasses found during spawning surveys. Juvenile salmon would be observed via snorkel surveys and captured (via backpack electrofishing and screw traps), anesthetized, weighed, measured, and released. A small subset of juvenile fish would be captured, marked (dye, elastomer, or fin clip), PIT-tagged, tissue sampled, and released. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 47. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 15486-3R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Spawned Adult/ Carcass	Natural	ST	100	0	-	-
	Juvenile	Natural	C/H/R	250	7	0.012	<0.001
		Natural	C/M, T, ST/R	50	2	0.002	<0.001
Northern California Steelhead	Spawned Adult/ Carcass	Natural	ST	700	0	-	-
	Juvenile	Natural	C/H/R	11,400	291	1.388	0.035
		Natural	C/M, T, ST/R	4,950	146	0.603	0.018
California Coastal Chinook salmon	Spawned Adult/ Carcass	Natural	ST	800	0	-	-
	Juvenile	Natural	C/H/R	2,000	60	0.156	0.005
Central California Coast coho salmon	Spawned Adult/ Carcass	Natural	ST	700	0	-	-
	Juvenile	Natural	C/M, T, ST/R	5,225	129	3.304	0.082
		Natural	C/H/R	7,525	247	4.759	0.156
Central California Coast Steelhead	Spawned Adult/ Carcass	Natural	ST	100	0	-	-
	Juvenile	Natural	C/H/R	175	5	0.070	0.002

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Natural	C/M, T, ST/R	25	1	0.010	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area in coastal streams throughout Northern California, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. Moreover, it is very likely that the impacts could be even smaller than those laid out above. In fact, over the past five years, the researchers have only taken 15.6% of their requested take and killed 2.35% of the requested mortalities.

Permit 17707-3R

Under Permit 17707-3R, the Center for Watershed Sciences at the University of California at Davis would be renewing a permit that since 2012 has authorized them to take adult and juvenile SacR winter-run and CVS Chinook salmon, CCV steelhead and SDPS green sturgeon. The project specifically targets splittail and other native minnow populations, however ESA-listed species may be taken as well.

Under this permit, juvenile fish would be captured (via otter trawling, beach seining, and electrofishing), handled and released. Adult fish would also be captured (via otter trawling, beach seining), handled, and released. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 48. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 17077-3R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/H/R	11	0	5.238	0.000
		Listed Hatchery Adipose Clip	C/H/R	11	0	0.493	0.000
	Juvenile	Natural	C/H/R	33	2	0.017	0.001
		Listed Hatchery Adipose Clip	C/H/R	33	2	0.016	0.001
Central Valley spring-run Chinook salmon	Adult	Natural	C/H/R	11	0	0.295	0.000
		Listed Hatchery Adipose Clip	C/H/R	11	0	0.484	0.000
	Juvenile	Natural	C/H/R	33	2	0.004	<0.001
		Listed Hatchery Adipose Clip	C/H/R	33	2	0.002	<0.001
California Central Valley Steelhead	Adult	Natural	C/H/R	11	0	0.652	0.000
		Listed Hatchery Adipose Clip	C/H/R	11	0	0.285	0.000
	Juvenile	Natural	C/H/R	33	2	0.005	<0.001
		Listed Hatchery Adipose Clip	C/H/R	33	2	0.002	<0.001
Southern DPS green sturgeon	Adult	Natural	C/M, T, ST/R	4	0	0.190	0.000
	Juvenile	Natural	C/H/R	23	0	0.524	0.000

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area in the Sacramento-San Joaquin Delta and Suisun Marsh, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. And it is likely that the impacts would be even smaller than those laid out above. Over the past five years, the researchers have never taken, let alone killed, any of the fish they were permitted.

Permit 17219-3R

Under permit 17219-3R the NMFS's Southwest Fisheries Science Center would be renewing a permit that since 2007 has authorized them to take juvenile and adult CCC, NC and S-CCC steelhead, and CCC and SONCC coho salmon to assess population abundance and dynamics; evaluate factors affecting growth, survival, and life-histories; assess life-stage specific habitat use and movement; inform various types of models (e.g., population, life-cycle, bioenergetics, and habitat-use models); determine genetic structure within populations; evaluate the effects how activities such as water management and habitat restoration affect populations; and develop improved sampling and monitoring methods.

Under this permit juvenile fish would be captured (via screw trap, backpack electrofishing, beach seines, hook and line fishing, and hand- or dip nets), handled, and released. A subset of the captured fish would be anesthetized, sampled (collection of scales, fin clips, or stomach contents), marked or tagged (using fin clips, PIT tags, pop-off satellite tags, acoustic tags, or radio tags), and released. In limited cases, some juvenile steelhead would be captured and euthanized for otolith and contaminant analysis. Adult steelhead and coho would be observed via spawning surveys, and tissue samples would be collected from carcasses found during those surveys. Adult steelhead would be captured (at fish ladders and by hook-and-line angling), tagged, tissue sampled, and released. With the exception of a small number of juvenile steelhead that would be sacrificed for otolith and contaminant research (above), the researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 49. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 17219-3R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release, IM= Intentional mortality.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Spawned Adult/ Carcass	Natural	ST	100	0	-	-
	Juvenile	Natural	C/M, T, ST/R	2,250	56	0.112	0.003
Northern California Steelhead	Juvenile	Natural	C/M, T, ST/R	1,000	25	0.122	0.003
		Natural	IM	100	100	0.012	0.012
Central California Coast coho salmon	Juvenile	Natural	C/M, T, ST/R	1,000	25	0.632	0.016
Central California Coast Steelhead	Spawned Adult/ Carcass	Natural	ST	25	0	-	-
	Juvenile	Natural	C/H/R	1,000	25	0.402	0.010
		Natural	C/M, T, ST/R	3,000	75	1.206	0.030
		Natural	IM	100	100	0.040	0.040
South-Central California Coast Steelhead	Adult	Natural	C/M, T, ST/R	250	6	35.971	0.863
	Spawned Adult/ Carcass	Natural	C/M, T, ST/R	25	1	-	-
		Natural	ST	25	0		
	Juvenile	Natural	C/H/R	4,500	113	5.692	0.143
		Natural	C/M, T, ST/R	15,250	381	19.290	0.482
		Natural	IM	100	100	0.126	0.126

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, for most species the researchers would take only a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place throughout CA coastal streams, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

For adult S-CCC steelhead, the proposed work could potentially kill 0.863% of the DPS, but the absolute number of adults requested is small (6 adults) and the percentage appears large because our current estimate of adult S-CCC abundance is low. This abundance estimate is likely an underestimate because it doesn't include populations for which we have no data and assumes the lowest conservative figures determined to be reliable. Moreover, this proposed research is intended, in part, to provide more accurate estimates. Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. Moreover, it is very likely that the impacts could be even smaller than those laid out above. In fact, over the past five years, the researchers have only taken 10.94% of their requested take and killed 1.09% of the requested mortalities.

Permit 17351-2R

Under permit 17361-2R, the Green Diamond Resource Company would be renewing a permit that since 2004 has authorized them to take juvenile and adult CC Chinook, SONCC coho, and NC steelhead to determine fish presence and distribution, monitor timing and abundance of out-migrating salmon, determine population estimates of summer rearing juveniles, and determine habitat use and relative number of spawning adults.

Under the permit, adult salmon would be observed during spawning surveys and tissue samples would be collected from carcasses found during those surveys. A small number of adult steelhead may also be captured during screw trapping. Juvenile salmon would be captured (via backpack electrofishing, snorkel surveys, and screw trapping), handled and released. A small subset of juvenile fish would be captured, anesthetized, marked, tagged, tissue sampled and released. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 50. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 17351-2R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Spawned Adult/ Carcass	Natural	ST	800	0	-	-
	Juvenile	Natural	C/H/R	31,285	635	1.554	0.032
		Natural	C/M, T, ST/R	14,550	292	0.723	0.015
Northern California Steelhead	Adult	Natural	C/H/R	200	2	2.770	0.028
	Spawned Adult/ Carcass	Natural	O/ST D	210	0	-	-
	Juvenile	Natural	C/M, T, ST/R	6,300	186	0.767	0.023
		Natural	C/H/R	33,095	930	4.029	0.113
California Coastal Chinook salmon	Spawned Adult/ Carcass	Natural	ST	1,025	0	-	-
	Juvenile	Natural	C/H/R	6,225	130	0.487	0.010
		Natural	C/M, T, ST/R	225	6	0.018	<0.001
Southern DPS Eulachon	Adult	Natural	C/M, T, ST/R	100	2	<0.001	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take only a small percent of any listed unit and kill an even smaller percent. Because the research would take place over such a broad area in multiple watershed in Northern California, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Thus, these numbers represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative affect on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. Also, the effect of these losses would to some extent be offset by the information generated from the research, which would be used to improve survival of the species in the future. Moreover, it is very likely that the impacts could be even smaller than those laid out above. In fact, over the past five years, the researchers have only taken 14.07% of their requested take and killed 0.51% of the requested mortalities.

Permit 18696-5M

Under Permit 18696-5M the IPC would continue work they have been conducting for nearly 10 years in the mainstem Snake River and add to it work they have long conducted under another permit (19846). They would use a number of capture methods. The first is a sinking style, small (5.1 cm stretch) multifilament mesh nets anchored to the bottom of Lower Granite Reservoir to fish for white sturgeon—these nets are deployed during the day and the sampling is conducted during the months of October and November in Lower Granite Reservoir between RM 138.5 (0.7 miles downstream from the confluence of the Clearwater River) downstream to RM 129.6 (1.3 miles downstream of Silcott Island). The second method is D-ring net sampling between the Salmon River confluence (RM 188) and the town of Lewiston, ID (RM 140) and that work takes place in the summer months. They would also use barbless angling to capture bull trout from December through March.

At each sample location for the sturgeon work, the researchers would record the river km, date and time of effort, depth fished, bottom water temperatures and dissolved oxygen levels. By-catch would be identified by species, counted, and measured for total length before being returned to the river. The exception to this is that all listed salmonids would be released with as little handling as possible, although the IPC would record the approximate size of all listed fish as well as noting any marks on the fish. The D-ring nets being employed only have a small chance of intercepting any salmonids, however, because any captured fish would spend some time in the net before they can be raised from the bottom of the river, there is a chance that they will not survive the encounter. As a result, the researchers will do everything in their power to both avoid listed salmonids and, when that is impossible, handle them only to the extent needed to get them back in the water.

The researchers are requesting the flowing levels of take:

Table 51. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 18696-5M. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Current Take	Current Lethal Take	Requested Take*	Requested Lethal Take*	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River spring/summer -run Chinook salmon	Adult	Natural	C/H/R	3	3	0	0	0.000	0.000
		Listed Hatchery Adipose Clip	C/H/R	3	3	0	0	0.000	0.000
	Juvenile	Natural	C/H/R	170	25	0	0	0.000	0.000
		Listed Hatchery Adipose Clip	C/H/R	170	25	0	0	0.000	0.000
Snake River fall-run Chinook salmon	Adult	Natural	C/H/R	8	4	10	0	0.097	0.000
		Listed Hatchery Adipose Clip	C/H/R	8	4	5	0	0.032	0.000
	Juvenile	Natural	C/H/R	101	18	5	0	<0.001	0.000
		Listed Hatchery Adipose Clip	C/H/R	101	18	5	0	<0.001	0.000
Snake River Basin Steelhead	Adult	Natural	C/H/R	8	4	75	1	0.711	0.009
	Juvenile	Natural	C/H/R	76	17	50	1	0.006	<0.001
Snake River sockeye salmon	Adult	Natural	C/H/R	3	0	0	0	0.000	0.000
	Juvenile	Natural	C/H/R	10	3	0	0	0.000	0.000

*The requested take and requested lethal take for a permit modification are represented as adjustments (positive or negative) to the amount of take previously permitted.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

Due to the nature of the proposed capture method, a good number of the fish that may be caught will be killed as a result. Nonetheless, even with those high mortality rates, the additional effect of the proposed modified research is expected to be minimal: No more than one adult fish out of one thousand for natural SnkR steelhead. In addition, because the research would take place in the mainstem Snake River, the losses cannot be ascribed to any population for any species—they must be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Moreover, the researchers would take a number of additional precautions with the aim of reducing impacts even further.

- First, a great deal of the work would take place in October and November, and thus it is timed so that it is very unlikely that any salmonids at all would be present in the action area.
- Second, the nets would be deployed on the reservoir and river bottom and extend no more than two meters up from it. Also, they would be perpendicular to, and within the thalweg. These deep main channel habitats are used only very infrequently by salmonids (if they are present at all), so this would further reduce the chance of catching any listed fish
- Third, the nets would be set only for short durations and monitored closely. This is also expected to reduce encounters with listed fish, but if any *are* encountered, the fish would not be handled if at all possible and the net would be cut if necessary to minimize harm.
- Finally, the researchers would primarily use a scheme of adaptive sampling. This would have the effect of focusing on areas shown to produce juvenile white sturgeon in the catch and exclude areas where ESA salmonids may be encountered. In addition, adaptive sampling would rely on sampling habitats of high juvenile sturgeon use which would be determined by tracking individuals with implanted sonic transmitters. In the event that telemetered juvenile white sturgeon habits overlap with those where listed salmonids are captured, sampling effort will be relocated to new locations with the hope of preventing further encounters with listed salmonids.

The result of all this is that the researchers are very unlikely to encounter any listed salmonids at all, and are extremely unlikely to reach the numbers displayed above. Over the past five years, the researchers have taken 20.88% of the requested total take and killed only 0.71% of the requested mortalities. Nonetheless, it is possible that they could have a maximum effect of the magnitude described above. But even in that instance, the effect would be very small, spread out across the entirely of each listing unit and, in any case, would be offset to some degree by the information on reservoir and fish community health the research is designed to generate.

Permit 18908-2R

Under permit 18908-2R, the SFEG would be renewing a permit that for the past five years has allowed them to annually take juvenile PS Chinook salmon and PS steelhead while conducting research to monitor how fish use side-channel habitat in floodplain and tributaries of the Skagit River in Washington. Under this project, small numbers of juvenile PS Chinook salmon and steelhead would be captured by beach seine, handled (weighed, measured, and checked for marks or tags), and released. As stated previously, the SFEG does not propose to kill any of the fish they capture, but a small number may die as an unintended result of the activities. The amount of take requested by SFEG is found in the following table.

Table 52. Total Requested Take and Mortalities by Species, Age, Origin, and Action relative to estimated abundances in the ESU/DPS for permit 18908-2R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	250	2	0.008	<0.001
		Listed Hatchery Adipose Clip	C/H/R	50	1	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	50	1	0.002	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table above demonstrates, the overall effect on the two species' abundance would be very small in all cases. However, the fish that may be taken would not be coming out of each species as a whole, but only the populations that reside in the Skagit River basin. Thus the overall effect on local abundance could be higher than the values in the table above. Data from planned hatchery releases in 2021 (WDFW 2020) and spawner counts from the Upper and Lower Skagit River from 2014-2018 (unpublished data, Mindy Rowse, NWFSC, July 14, 2020) indicate we would expect approximately one million each of natural-origin and adipose clipped hatchery-origin outmigrating juvenile PS Chinook salmon (i.e., 947,310 natural-origin and 1,087,500 clipped hatchery-origin juveniles) in the Skagit Basin. An additional 300,000 unclipped hatchery-origin juveniles that can't be distinguished from natural-origin juveniles in this study (and would therefore be counted as natural-origin if captured) are also planned to be released in the Skagit Basin in 2021 (WDFW 2020). No hatchery releases of PS steelhead are planned for the Skagit Basin in 2021, however WDFW spawner counts from 2014-2018 (WDFW 2021, data accessed on February 25, 2021 from WDFW Steelhead - General Information Page) indicate an estimated 856,175 natural-origin outmigrating juveniles would be present. Therefore, the percent of Skagit Basin juveniles taken by this study can be estimated as shown in the table below.

Table 53. Total Requested Take and Mortalities by Species, Age, Origin, and Action relative to expected outmigrant abundances in the Skagit Basin for permit 18908-2R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of Skagit outmigrants taken	Percent of Skagit outmigrants killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	250	2	0.026	<0.001
		Listed Hatchery Adipose Clip	C/H/R	50	1	0.005	<0.001
Puget Sound Steelhead		Natural	C/H/R	50	1	0.006	

Thus, these numbers still represent very small impacts on the local abundance (and therefore productivity) and, as such, they are unlikely to have any long-term negative effects on the local populations' survival—particularly given that there is not likely to be any measurable effect on the populations' structure or diversity. The purpose of the research is to assess juvenile salmonid habitat use and relative abundance in off-channel areas and thereby help improve efforts to increase access to off-channel areas and enhance rearing habitat quality in those areas. The effect of these losses would to some extent be offset by the information generated from the research, which would be used to guide habitat restoration projects that would improve survival of the species in the future. It is also likely that the impacts would be even smaller than those laid out above: for this project over the past five years, only 4.35 percent of the requested total take and zero percent of the requested mortalities occurred.

Permit 19320-2R

Under the renewed Permit 19320, the SWFSC would continue marine research they have been performing for half a decade regarding salmonids in the California current. The work is designed to produce a great deal of information on poorly understood aspects of the salmonid life cycle: (a) interannual and seasonal variability of growth, feeding, energy status; and (b) and spatial distribution of juvenile salmonids in the coastal ocean off northern and central California during their early ocean residence. The researchers would also seek to (a) characterize prominent biological and physical oceanographic features associated with juvenile salmon ocean habitat from shore to the continental shelf break; (b) identify potential links between coastal geography, oceanographic features, and salmon distribution patterns, energy status, and diet; (c) quantify and describe the coastal pelagic fish and invertebrate community associated with juvenile salmon; and (d) identify and test promising ecological salmon survival indices.

The SWFSC could employ four different methods to capture the fish:

1. Surface trawling from a contracted commercial vessel or NOAA research vessel using a 264 Nordic rope trawl (approximate dimensions 22m x 18m mouth opening and 200m total length with 15mm stretched mesh codend liner, towed for 30 minutes. For each tow, invertebrates and non-salmonid fishes would be identified and counted (or counts estimated by subsampling), and 30 individuals of each species measured. All salmonids would be identified and measured (fork length, FL). All juvenile salmonids (80-250mm FL) would be are lethally sampled and individually frozen in plastic bags for transport back to shore. Scales, caudal fin clips, and in some cases blood plasma samples would be taken from each juvenile salmonid before freezing. Subadult salmonids (>250mm FL) would either be kept or released, depending on their condition after capture. All subadult salmon and steelhead would immediately be placed in aerated seawater live wells after hauling the net. Those that survive capture are would be after tissue sampling. Subadult salmon that are lethally sampled are would either kept intact and frozen or partially dissected in-situ for transport back to shore and subsequent analysis.

2. Beach seining along the coast between San Francisco and the CA/OR border. Seine dimensions: 1.5m wide x 15m long with a mesh of 10mm—small enough to be operated by 3 persons wading out from shore. Approximately 5-10 seine stations may be sampled annually, with locations to be determined.

3. Microtrolling using modified hook and line angling. This sampling would be done using downriggers with braided Dacron line and weighted with a 15 lb. lead ball. Leaders would 200 cm of 150 lb. test monofilament, a flasher, then 50 cm of terminal gear with 10 lb. test and a size 0 Dick Nite spoon. Leaders would be attached directly to the downrigger line, and barbless hooks would be employed.

4. Purse Seining using a fine mesh purse seine 10.6 m deep x 155 m long, with stretched mesh opening 1.7 cm and knotless bunt mesh 1.5 cm. Each sample would include an enclosed circle the size of the length of the net (155 m perimeter).

The fish captured by methods 2-4 would undergo the same procedures laid out in procedure 1. The researchers are requesting the following amounts of take:

Table 54. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 19320-2R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release, IM=Intentional mortality.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River spring/summer -run Chinook salmon	Juvenile	Listed Hatchery Adipose Clip	IM	2	2	<0.001	<0.001
Lower Columbia	Adult	Natural	C/M, T, ST/R	1	0	0.003	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
River Chinook salmon		Listed Hatchery Adipose Clip	C/M, T, ST/R	1	0	0.003	0.000
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	C/M, T, ST/R	10	0	0.110	0.000
			IM	6	6	0.066	0.066
		Listed Hatchery Intact Adipose	C/M, T, ST/R	10	0	0.265	0.073
			IM	6	6		
		Listed Hatchery Adipose Clip	C/M, T, ST/R	11	0		
			IM	2	2		
	Juvenile	Natural	IM	48	48	0.002	0.002
		Listed Hatchery Intact Adipose	IM	48	48	0.008	0.008
		Listed Hatchery Adipose Clip	IM	11	11	0.006	0.006
Northern California Steelhead	Adult	Natural	C/M, T, ST/R	1	0	0.014	0.000
		Natural	IM	5	5	0.069	0.069
	Juvenile	Natural	IM	7	7	<0.001	<0.001
California Coastal Chinook salmon	Adult	Natural	IM	10	10	0.142	0.142
		Natural	C/M, T, ST/R	34	0	0.483	0.000
	Juvenile	Natural	IM	31	31	0.002	0.002
Sacramento River winter-run Chinook salmon	Adult	Natural	IM	2	2	0.952	0.952
	Juvenile	Natural	IM	2	2	0.001	0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central Valley spring-run Chinook salmon	Adult	Natural	C/M, T, ST/R	8	0	0.215	0.000
		Natural	IM	1	1	0.027	0.027
		Listed Hatchery Adipose Clip	IM	2	2	0.088	0.088
		Listed Hatchery Adipose Clip	C/M, T, ST/R	6	0	0.264	0.000
	Juvenile	Natural	IM	23	23	0.003	0.003
		Listed Hatchery Adipose Clip	IM	82	82	0.004	0.004
California Central Valley Steelhead	Adult	Natural	C/M, T, ST/R	1	0	0.059	0.000
		Natural	IM	3	3	0.178	0.178
		Listed Hatchery Adipose Clip	IM	10	10	0.259	0.259
	Juvenile	Natural	IM	4	4	<0.001	<0.001
		Listed Hatchery Adipose Clip	IM	2	2	<0.001	<0.001
Central California Coast coho salmon	Adult	Natural	C/M, T, ST/R	3	0	0.155	0.000
		Natural	IM	2	2	0.104	0.104
		Listed Hatchery Intact Adipose	C/M, T, ST/R	3	0	0.917	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Intact Adipose	IM	2	2	0.612	0.612
	Juvenile	Natural	IM	16	16	0.010	0.010
		Listed Hatchery Intact Adipose	IM	16	16	0.010	0.010
Central California Coast Steelhead	Adult	Natural	C/M, T, ST/R	1	0	0.046	0.000
		Natural	IM	5	5	0.229	0.229
		Listed Hatchery Adipose Clip	IM	5	5	0.129	0.129
	Juvenile	Natural	IM	7	7	0.003	0.003
		Listed Hatchery Adipose Clip	IM	1	1	<0.001	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table illustrates, for most species, the research would affect from zero fish to a few hundredths of a percent of the listed unit. In a few instances, that effect could range from a few tenths of one percent up to nearly 1% for natural SRWR Chinook adults. Because the research would take place in the marine environment, its effects would be spread out across the entirety of each listed unit and no single population would be disproportionately affected. Thus, the effects displayed can be analyzed only in the context of each listed unit as a whole.

The largest possible effect—the loss of 0.95% of the SacR Chinook adults—would mean a small loss in abundance and productivity for that ESU, but there would be no discernable effect on diversity or structure. However, there are a number of reasons to believe that the displayed effect would be a great deal smaller than 0.95%. First, in the previous five years the holders of permit 19320 have never captured, let alone killed, a SacR adult. In most years, they have killed no fish at all from any listed unit: over the past four years, the researchers have taken only 2.99% of their requested total take and killed 3.22% of the requested mortalities. Second, the fish most likely to be captured and killed would actually be subadults rather than full-fledged adults and would therefore represent an age class with a great deal more abundance; still we count them as adults to examine the worst-case scenario. Third, the most likely activity for the next several years is actually the least intrusive and harmful: the microtrolling with hook-and-line angling equipment. We include the other types of gear (trawling, seining) to assess the maximum possible negative effect, but the likelihood is that the other gear types would not be employed at all and therefore all the effects would be a great deal smaller than those displayed. In fact, many of the "intentional mortalities" displayed in the table above are there because of the possibility that trawling gear may be used and most fish do not survive trawling. If the researchers do not conduct trawls, nearly all the mortalities for adult fish would be prevented.

Nonetheless, in even the worst case scenario (one in which up to two adults from various species may be killed), the small effects on abundance and productivity would be offset to some degree by the information to be obtained—information that the SWFSC would use to help conserve salmonids up and down the West Coast.

Permit 19738-2R

Under permit 19738-2R the WA DNR would be renewing a permit that for the past five years has allowed them to annually take juvenile PS Chinook salmon and PS steelhead while conducting research to verify stream typing in headwater streams on state owned lands across several watersheds in Washington state that drain to Puget Sound. Under this project, small numbers of juvenile PS Chinook salmon and steelhead would be encountered via backpack electrofishing, and if stunned, would be briefly handled (dip-netted) to be moved to a low-gradient area for release. As stated previously, the WA DNR does not propose to kill any of the fish they capture, but a small number may die as an unintended result of the activities. The amount of take requested by WA DNR is found in the following table.

Table 56. Total Requested Take and Mortalities by Species, Age, Origin, and Action relative to estimated abundances in the ESU/DPS for permit 19738-2R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001
		Listed Hatchery Adipose Clip	C/H/R	10	1	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table above demonstrates, the overall effect on the two species' abundances would in all cases be very small. In addition, any losses would be distributed across several watersheds in the species' ranges, would not disproportionately affect any particular population, and therefore are not likely to have any measurable effect on the species' structure or diversity. It is also very unlikely the researchers would encounter salmonids at any of the sampling locations and therefore probable that the impacts would be even smaller than those laid out above. Over the past five years of this project the researchers have never encountered a single PS Chinook salmon or steelhead in their surveys, so the true effects are likely to be at or near zero handling and mortality. The purpose of the research is to determine fish presence/absence in small streams to ensure they are appropriately typed, adequately protected with riparian management zones, and restored via removal of manufactured structures that restrict fish passage when authorizing projects. Therefore, any negative impacts of take that may occur from research would likely be offset to some degree by the beneficial management and restoration actions that would be triggered if detecting listed fish were to be detected in a stream in a proposed project area.

Permit 19741-2R

Under Permit the renewed 19741, The Yakama nation would continue and expand upon a suite of activities that have previously been allowed under another section 10 permit or under an ESA section 4(d) authorization. The researchers would use boat-and backpack electrofishing equipment to capture MCR steelhead juveniles. Some juveniles larger than 70mm would be PIT-tagged, some may be marked with a dye, and a small number of fish would also be tissue-sampled. The majority of the captured fish, however, would simply be anesthetized, handled, measured, and released. The researchers would also explore less intrusive methods of capturing fish (i.e., snorkeling, seining, and minnow trapping) and seek in the future to use them in place of electrofishing.

The boat electrofishing would be restricted to the Rock Creek inundated pool and would be conducted for only limited periods of time when adult steelhead are not present. Also, it would be targeting piscivorous species (juvenile steelhead predators) in the pool rather than steelhead themselves. The researchers may also sample some adult steelhead carcasses while conducting spawning surveys.

The researchers are requesting the following levels of take:

Table 57. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 19741-2R. (C=Capture, H=Handle, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River Steelhead	Juvenile	Natural	C/H/R	10,000	200	2.453	0.049
		Natural	C/M, T, ST/R	9,500	190	2.330	0.047

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

Because the vast majority of the fish that would be captured are expected to recover with no ill effects, the true effects of the proposed action are best seen in the context of the fish that the action is likely to kill. Based on in the recent average juvenile outmigration numbers, this means that the researchers could kill up to about 0.1% of the juvenile outmigration for the species' natural component, however that effect would be magnified at the local level because the research is only taking place in Rock Creek and other nearby streams.

We do not know how many natural steelhead outmigrants Rock Creek produces, but a review of the reports from previous authorizations the Yakama has had to do work in rock Creek indicates, first, that they would not under any circumstances catch all of the juveniles outmigrating from the system, and second, that the mortality rates they have seen have seen over the last ten years of operation have been well under 3%. Therefore, under even the most conservative scenario, the research would kill far less than 3% of whatever outmigration were to occur.

And given that researchers are planning to survey far less than half the Rock Creek system (as well as those of nearby creeks), that would signify that the researchers are very unlikely to kill more than 1% of the potential outmigration from Rock Creek under even the most intrusive possible scenario. The permit's history bears this out: over the past three years, the researchers have taken only 7.09% percent of the requested total take and killed 6.41% of the requested mortalities. In addition, the vast majority of the juveniles that researchers may encounter would not be smolts in any case; they would almost all be age-0 fish that are not ready for outmigration and the majority of those would be fry—an age class that is in the range of an order of magnitude more numerous than smolts. So the actual effect would be felt mostly by that more numerous age class.

But even if the worst case were to occur, and the researchers were to kill something on the order of 1% of the outmigrating juveniles from Rock Creek (and nearby creeks), that would still be a very small effect at the local level and would be seen only in small changes in abundance and productivity—diversity and structure are not likely to be measurably affected—and that would be even more true at the DPS level. And even those small losses would to some extent be offset by the benefit in terms of habitat restoration and species recovery that the research is expect to generate.

Permit 22482-2R

As noted previously, issuing permit 22482 would authorize the NWFSC to take juvenile LCR, SnkR fall-run, UCR spring-run, and UWR Chinook salmon; CR chum salmon; LCR coho salmon; SnkR sockeye salmon; and LCR, MCR, SnkR basin, UCR, and UWR steelhead in the lower Willamette River (Oregon). Using vinyl-coated wire shrimp traps with 1.0 cm x 0.5 cm openings and baited with canned meat and bait scent, any listed salmonids (unintentionally captured) would be transferred to buckets of aerated water, identified, counted, checked for fin clips, passive integrated transponder, and coded wire tags, and then gently released near the site of capture. The researchers are requesting the following amounts of take:

Table 58. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 22482-2R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Columbia River spring-run Chinook salmon	Juvenile	Natural	C/H/R	50	1	0.011	<0.001
		Listed Hatchery Intact Adipose	C/H/R	10	0	0.003	0.000
		Listed Hatchery Adipose Clip	C/H/R	20	1	0.003	<0.001
Upper Columbia River Steelhead	Juvenile	Natural	C/H/R	2	0	0.001	0.000
		Listed Hatchery Intact Adipose	C/H/R	2	0	0.001	0.000
		Listed Hatchery Adipose Clip	C/H/R	2	0	<0.001	0.000
Middle Columbia River Steelhead	Juvenile	Natural	C/H/R	2	0	<0.001	0.000
		Listed Hatchery Intact Adipose	C/H/R	2	0	0.002	0.000
		Listed Hatchery Adipose Clip	C/H/R	2	0	<0.001	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River fall-run Chinook salmon	Juvenile	Natural	C/H/R	50	1	0.007	<0.001
		Listed Hatchery Intact Adipose	C/H/R	10	0	<0.001	0.000
		Listed Hatchery Adipose Clip	C/H/R	20	1	<0.001	<0.001
Snake River Basin Steelhead	Juvenile	Natural	C/H/R	2	0	<0.001	0.000
		Listed Hatchery Intact Adipose	C/H/R	2	0	<0.001	0.000
		Listed Hatchery Adipose Clip	C/H/R	2	0	<0.001	0.000
Snake River sockeye salmon	Juvenile	Natural	C/H/R	2	0	0.010	0.000
		Listed Hatchery Adipose Clip	C/H/R	2	0	<0.001	0.000
Lower Columbia River Chinook salmon	Juvenile	Natural	C/H/R	50	1	<0.001	<0.001
		Listed Hatchery Intact Adipose	C/H/R	10	0	0.001	0.000
		Listed Hatchery Adipose Clip	C/H/R	20	1	<0.001	<0.001
Lower Columbia River coho salmon	Juvenile	Natural	C/H/R	20	1	0.003	<0.001
		Listed Hatchery Intact Adipose	C/H/R	5	0	0.002	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/H/R	10	0	<0.001	0.000
Lower Columbia River Steelhead	Juvenile	Natural	C/H/R	2	0	<0.001	0.000
		Listed Hatchery Intact Adipose	C/H/R	2	0	0.022	0.000
		Listed Hatchery Adipose Clip	C/H/R	2	0	<0.001	0.000
Columbia River chum salmon	Juvenile	Natural	C/H/R	20	1	<0.001	<0.001
		Listed Hatchery Intact Adipose	C/H/R	5	0	<0.001	0.000
		Listed Hatchery Adipose Clip	C/H/R	10	0	-	-
Upper Willamette River Chinook salmon	Juvenile	Natural	C/H/R	120	2	0.010	<0.001
		Listed Hatchery Intact Adipose	C/H/R	20	1	0.475	0.024
		Listed Hatchery Adipose Clip	C/H/R	40	1	<0.001	<0.001
Upper Willamette River Steelhead	Juvenile	Natural	C/H/R	4	0	0.003	0.000

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table illustrates, the proposed effects are very small. In fact, the levels of effect associated with the proposed work are as close to zero as it is possible to get and they would probably not even be as large as those displayed because in the previous two years this permit has been in effect, the researchers have never captured, let alone killed, a single listed fish. Moreover, because the researchers are operating in the mainstem of the Willamette River, the losses cannot be ascribed to any population for any species—they must be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small (nearly zero) impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any listed species.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the study is to assess injury and associated exposure to contaminants in Portland Harbor forage fish—an essential component of the aquatic food web. The research would benefit the affected species by helping managers guide the Portland harbor clean-up and thereby improve salmonid habitat in the lower Willamette River.

Permit 23029-2R

Under permit 23029-2R the NWFSC would be renewing a permit that for the past two years has allowed them to annually take adult and juvenile PS Chinook salmon, juvenile PS steelhead, juvenile bocaccio and yelloweye rockfish, and adult and juvenile S eulachon while conducting research to evaluate contaminants in tissues of resident flatfish in support of a Natural Resource Damage Assessment in the Lower Duwamish River. Under this project, ESA-listed fish may be unintentionally captured by beach seine or otter trawl during sampling targeting English sole and starry flounder across several estuaries and bays in Puget Sound, Washington. Non-target fish caught would be identified, counted, and salmonids checked for markings (i.e., fin clips, PIT tags, coded wire tags), and all non-target species would be quickly released at the capture site. As stated previously, the NWFSC does not propose to kill any ESA-listed fish as part of this sampling, but a small number may die as an unintended result of these activities. The amount of take requested by NWFSC is found in the following table.

Table 59. Total Requested Take and Mortalities by Species, Age, Origin, and Action relative to estimated abundances in the ESU/DPS for permit 23029-2R. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Adult	Natural	C/H/R	10	1	0.047	0.005

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon		Listed Hatchery Intact Adipose	C/H/R	10	1	0.111	0.011
		Listed Hatchery Adipose Clip	C/H/R	10	1		
	Juvenile	Natural	C/H/R	1,050	15	0.033	<0.001
		Listed Hatchery Intact Adipose	C/H/R	1,050	15	0.014	<0.001
		Listed Hatchery Adipose Clip	C/H/R	1,050	15	0.002	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	510	7	0.023	<0.001
		Listed Hatchery Intact Adipose	C/H/R	510	7	0.453	0.006
		Listed Hatchery Adipose Clip	C/H/R	510	7	0.464	
Puget Sound/Georgia Basin DPS bocaccio	Juvenile	Natural	C/H/R	10	2	0.217	0.043
Puget Sound/Georgia Basin DPS yelloweye rockfish	Juvenile	Natural	C/H/R	10	2	0.015	0.003
	Adult	Natural	C/H/R	60	4	<0.001	<0.001

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern DPS Eulachon	Juvenile	Natural	C/H/R	60	4		

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table above demonstrates, the overall effect on ESA-listed species' abundance would in all cases be very small. In addition, any losses would be distributed across several locations in the estuarine and marine zones of the species' ranges, would not disproportionately affect any particular population, and therefore are not likely to have any measurable effect on the species' structure or diversity. It is also possible that the impacts could be even smaller than those laid out above. Typically, total take and mortalities that actually occur are only a portion of those authorized, although for the past two years sampling under this project was not conducted due to field restrictions, so more precise estimates of the actual take anticipated are not yet available. For the purposes of this analysis, we assume all authorized take could occur, and still find that though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. The purpose of the research is to inform a Natural Resources Damage Assessment regarding contamination in the Lower Duwamish River, and guide clean-up and restoration efforts. The effect of losses due to research would therefore to some extent be offset by the information generated from the research, which when used to improve estuarine habitat would benefit survival of the species in the future.

Permit 23649-2M

Permit 23649-2M would allow Mt. Hood Environmental to continue taking juvenile MCR steelhead in the one-mile reach below Bowman Dam on the Crooked River in Oregon. The permit would be modified by increasing the amount of natural fish that might be taken and decreasing the number of hatchery fish. The researchers would use single-pass backpack electrofishing units and a screw trap near the dam's outlet to capture the fish. Once captured, the fish would be individually identified to species, measured, weighed, and their condition noted. They would then be released back to the river near the site of their capture. NMFS's electrofishing guidelines would be followed at all times. The screw trapping operation would continue for three to four one-month periods to capture seasonal variability. In each instance, the trap would be checked daily and the fish would undergo the same procedures as those described for the electrofishing effort. The researchers are requesting the following levels of take:

Table 60. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 23649-2M. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Current Total Take	Current Lethal Take	Requested Take*	Requested Lethal Take*	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River Steelhead	Juvenile	Natural	C/H/R	600	18	1,300	21	0.319	0.005
		Listed Hatchery Intact Adipose	C/H/R	600	18	-500	-16	-0.453	-0.014

*The requested take and requested lethal take for a permit modification are represented as adjustments (positive or negative) to the amount of take previously permitted.

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table illustrates, the research would have, at most, a very small effect on any component of the MCR steelhead DPS. However, to understand what those figures actually mean, two things must be take into consideration: First, the effect would be localized to only those fish produced in the Deschutes River. While we do not know how many fish this population group produces, it would be conservative to say that at least 10% of the natural fish in the DPS come from there, and some larger percentage of the intact-adipose hatchery fish. That would mean that at the local level, the research may kill as much as 0.05% of the natural fish and something approaching 0.03% of the intact-adipose hatchery origin fish. In both cases, these are very small effects at the local level and nearly unmeasurable at the level of the listed unit.

Second, and as noted above, all of the fish would actually be coming from the Deschutes River NEP—an experimental population that is considered, in its entirety, to be excess to the MCR steelhead's recovery needs. As a result, the loss of so few juvenile fish is unlikely to have a measurable impact on even the species' abundance and productivity—let alone structure or diversity. But even that nearly inconsequential loss would be offset to some degree by the data to be gained from the research—data that would be sued in the future to operate Bowman Dam in as fish-friendly a manner as possible.

Permit 24151

As noted previously, issuing permit 24151 would authorize the USFS to capture juvenile OC coho and SDPS green sturgeon while evaluating the interactions between coho salmon and bass in Oregon coastal lakes. The researchers would use beach seines, boat seins, minnow traps, barbless hook-and-line angling, and backpack electrofishing to capture the fish which would then be anesthetized, measured, weighed, allowed to recover, and released. Bass would also be sampled for their stomach contents and, while some OC coho may be encountered that way, those fish would already be dead. The researchers are requesting the following amounts of take:

Table 61. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 24151. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Oregon Coast coho salmon	Juvenile	Natural	C/H/R	950	15	0.014	<0.001
Southern DPS green sturgeon	Adult	Natural	C/H/R	1	0	0.047	0.000

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table illustrates, at the DPS level, the research would have on a very small effect on OC coho abundance (and therefore productivity) and no measurable impact on structure or diversity. However, that small effect would be magnified to some degree by the fact that it would be restricted entirely to Tahkenitch Lake, in Oregon. We do not know how many OC coho Tahkenitch lake produces, however, even if it only very conservatively produced one one-thousandth of the 6.64 million OC coho salmon outmigrating every year (see status section), that would still mean that the research would kill, at most, 0.02% of the local OC coho (and no sturgeon at all). This is a very small abundance and productivity effect and likely no effect at all on diversity and structure. And even that very small effect would by offset to some degree by the information to be generated. Helping managers better understand predator/prey relationships in Oregon's coastal lakes will them better protect the fish listed there.

Permit 24255

As noted previously, issuing permit 24255 would authorize the CDFW Fish Restoration Program to take juvenile and adult SacR winter-run and CVS Chinook salmon, CCV steelhead, and SDPS green sturgeon to assess the effectiveness of habitat restoration.

Under this permit adult fish would be captured (via otter trawl, lampara seine), handled, and released. Juvenile fish could be captured (via beach seine, otter trawl, lampara seine, zooplankton net, backpack electrofishing) handled, and released. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 62. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 24255. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/H/R	1	0	0.476	0.000
		Listed Hatchery Adipose Clip	C/H/R	1	0	0.045	0.000
	Juvenile	Natural	C/H/R	55	2	0.028	0.001
		Listed Hatchery Intact Adipose	C/H/R	4	0	-	-
		Listed Hatchery Adipose Clip	C/H/R	6	0	0.003	0.000
Central Valley spring-run Chinook salmon	Adult	Natural	C/H/R	1	0	0.027	0.000
		Listed Hatchery Adipose Clip	C/H/R	1	0	0.044	0.000
	Juvenile	Natural	C/H/R	75	2	0.010	<0.001
		Listed Hatchery Adipose Clip	C/H/R	35	2	0.002	<0.001
California Central Valley Steelhead	Adult	Natural	C/H/R	2	0	0.119	0.000
		Listed Hatchery Adipose Clip	C/H/R	2	0	0.052	0.000
	Juvenile	Natural	C/H/R	5	0	<0.001	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/H/R	15	0	<0.001	0.000
Southern DPS green sturgeon	Adult	Natural	C/H/R	1	0	0.047	0.000
	Juvenile	Natural	C/H/R	1	0	0.023	0.000

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in the last column of the table above.

As the table illustrates, the researchers would take a very small percent of any listed unit and kill an even smaller percent of those units (zero, or nearly so in all cases). Because the research would take place over such a broad area, in Sacramento-San Joaquin Delta including Suisun Marsh and Grizzly Bay, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

Permit 24367

As noted previously, issuing permit 24367 would authorize the NWFSC to take juvenile PS Chinook salmon, PS steelhead, and HCS chum salmon in nearshore zones in the San Juan Islands, near Whidbey Island, and in central and southern Puget Sound, Washington. Using lampara seines, nearshore fish assemblages would be targeted for sampling across ten sites. At each sampling site, a small number of juvenile PS Chinook salmon and HCS chum salmon captured would be immediately euthanized and placed on ice for transfer to the NWFSC for stable isotope analysis. All additional and non-target fish captured would be kept for a minimal time in aerated buckets of fresh seawater prior to being released at the capture site. The NWFSC is proposing to kill a small number of juvenile PS Chinook salmon and HCS chum salmon as part of this sampling, and in addition, a small number of juvenile ESA-listed fish may die as an unintended result of these activities. The researchers are not proposing to capture or kill any adult ESA-listed fish. The amount of take requested by NWFSC is found in the following table.

Table 63. Total Requested Take and Mortalities by Species, Age, Origin, and Action relative to estimated abundances in the ESU/DPS for permit 24367. (C=Capture, H=Handle, R=release, IM= Intentional mortality.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	580	3	0.018	<0.001
		Natural	IM	100	100	0.003	0.003
		Listed Hatchery Intact Adipose	C/H/R	505	3	0.007	<0.001
		Listed Hatchery Intact Adipose	IM	100	100	0.001	0.001
		Listed Hatchery Adipose Clip	C/H/R	275	3	<0.001	<0.001
		Listed Hatchery Adipose Clip	IM	100	100	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	6	3	<0.001	<0.001
		Listed Hatchery Intact Adipose	C/H/R	3	3	0.003	0.003
		Listed Hatchery Adipose Clip	C/H/R	3	3	0.003	0.003
Hood Canal summer-run chum salmon	Juvenile	Natural	C/H/R	90	3	0.002	<0.001
		Natural	IM	15	15	<0.001	<0.001
		Listed Hatchery Intact Adipose	C/H/R	100	3	0.067	0.002
		Listed Hatchery Intact Adipose	IM	15	15	0.010	0.010

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/H/R	70	3	-	-
		Listed Hatchery Adipose Clip	IM	15	15	-	-

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected (see status section) for the species—these figures are presented in the last column of the table above.

As the table above demonstrates, the overall effect on ESA-listed species' abundance would in all cases be very small. In addition, any losses would be distributed across several locations in the estuarine and marine zones of the species' ranges, would not disproportionately affect any particular population, and are therefore not likely to have any measurable effect on the species' structure or diversity. It is also possible that the impacts could be even smaller than those laid out above. Typically, total take and mortalities that actually occur are only a portion of those authorized, although more precise estimates of the actual take rates anticipated are not yet available for this study. For the purposes of this analysis, we assume all authorized take could occur, and still find that though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. The purpose of the research is to evaluate how shoreline armoring affects nearshore fish assemblages, evaluate effectiveness of restoration efforts on these assemblages, and provide a database of fish habitat use to guide restoration efforts in Puget Sound. Therefore, the effect of losses due to research would to some extent be offset by the information generated from the research, which when used to improve nearshore habitats would benefit survival of the species in the future.

Permit 25409

As noted previously, issuing permit 25409 would authorize researchers from OSU to do fish and invertebrate community assays at several different locations throughout the Willamette Valley in Oregon. This project is actually mandated by Oregon State Legislature (HB 2437 SECTION 10.) and is designed to help the Oregon Department of Agriculture in develop adaptive management recommendations related to agriculture ditch cleaning and its effects on the biological community. The fish would be captured by minnow trapping, electrofishing, and seine netting and then they would be identified, counted, measured, and released to the same area from which they were initially taken. Listed species would be processed and released before any work is done on any other captured species. The researchers are requesting the following amounts of take:

Table 64. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 25409. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Willamette River Chinook salmon	Juvenile	Natural	C/H/R	2,400	24	0.198	0.002
Upper Willamette River Steelhead	Juvenile	Natural	C/H/R	2,400	24	1.709	0.017

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are presented in that last column of the table above.

This signifies that the research may thus cause the death of a very small number of juvenile fish: the permitted activities may kill no more than 0.002% of the expected abundance for either the listed salmon or steelhead. Moreover, that take (and any of its potential impacts) would be spread out over randomly selected sites throughout the Willamette Valley (above Willamette Falls). Thus, no population is likely to experience a disproportionate amount of even these small losses. As a result, the activities are likely to have only a minimal impact on species abundance (and therefore productivity) and no appreciable impact on structure or diversity.

An effect of the research that cannot be quantified is the benefit to the species' conservation resulting from the research. The purpose of the research is to help the Oregon Department of Agriculture develop management recommendations that would protect and preserve listed species that stray into agricultural ditches.

Permit 25463

As noted previously, issuing Permit 25463 would authorize the Moss Landing Marine to take adult and juvenile SacR winter-run, CVS, and CC Chinook salmon; SONCC and CCC coho salmon; CCV, CCC, NC, S-CCC and SC steelhead; and SDPS steelhead to (1) measure contaminant levels in fish and shellfish over time to track temporal trends and evaluate the effectiveness of management efforts; (2) help managers evaluate contaminant spatial patterns; (3) perform Clean Water Act assessments; and (4) create and update human health advisories and assessments.

Under this permit fish would be captured (via electrofishing, hook-and-line angling, otter trawls, cast nets, beach seines, gill nets, and minnow traps), handled, and released. The researchers are not proposing to kill any of the listed fish being captured.

Table 65. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 25463. (C=Capture, H=Handle, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	C/H/R	12	0	0.132	0.000
	Juvenile	Natural	C/H/R	8	0	<0.001	0.000
Northern California Steelhead	Adult	Natural	C/H/R	12	0	0.166	0.000
	Juvenile	Natural	C/H/R	8	0	0.0010	0.000
California Coastal Chinook salmon	Adult	Natural	C/H/R	12	0	0.171	0.000
	Juvenile	Natural	C/H/R	8	0	<0.001	0.000
Sacramento River winter-run Chinook salmon	Adult	Natural	C/H/R	7	0	3.333	0.000
	Juvenile	Natural	C/H/R	7	0	0.004	0.000
Central Valley spring-run Chinook salmon	Adult	Natural	C/H/R	7	0	0.188	0.000
	Juvenile	Natural	C/H/R	7	0	<0.001	0.000
California Central Valley Steelhead	Adult	Natural	C/H/R	7	0	0.415	0.000
	Juvenile	Natural	C/H/R	7	0	0.001	0.000
Central California Coast coho salmon	Adult	Natural	C/H/R	12	0	0.621	0.000
	Juvenile	Natural	C/H/R	8	0	0.005	0.000
Central California Coast Steelhead	Adult	Natural	C/H/R	12	0	0.549	0.000
	Juvenile	Natural	C/H/R	8	0	0.003	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
South-Central California Coast Steelhead	Adult	Natural	C/H/R	12	0	1.727	0.000
	Juvenile	Natural	C/H/R	8	0	0.010	0.000
Southern California Steelhead	Adult	Natural	C/H/R	12	0	-	-
	Juvenile	Natural	C/H/R	8	0		
Southern DPS green sturgeon	Adult	Natural	C/H/R	9	0	0.427	0.000
	Juvenile	Natural	C/H/R	8	0	0.182	

Because the all of the fish that may be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, issuing this permit is not likely to harm any of the species in question to any measurable degree. The researchers have been performing this work under other permits for many years and have never killed a single fish from any of the species they have ever encountered. Should this change, and they do kill a fish, the research will be re-evaluated, but if the effects are as currently estimated (and displayed in the table above), the work would not perceivably alter any VSP for any listed species—their structure, diversity, productivity, and abundance would all remain essentially unchanged by the proposed activity.

Permit 25466

As noted previously, issuing permit 25466 would authorize the TRPA Fish Biologists to take juvenile and adult steelhead to study the distribution, relative abundance, diversity, and health of fish in the Lower Sacramento River.

Under this permit, fish would be captured via backpack electrofishing, anesthetized, measured, weighed, tissue sampled, and released. The researchers are not proposing to kill any of the fish being captured, but a small number of juveniles may be killed as an inadvertent result of these activities.

Table 66. Proposed take and comparison of possible lethal take to annual abundance at the ESU/DPS scale under Permit 25466. (C=Capture, T=Tag, M=Mark, ST=Sample tissue, R=release.)

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Adult	Natural	C/M, T, ST/R	2	0	0.119	0.000

Species	Life Stage	Origin	Take Action	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
California Central Valley Steelhead	Juvenile	Natural	C/M, T, ST/R	20	2	0.003	<0.001

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

As the table illustrates, the researchers would take a very small percent of the listed unit—and kill an even smaller percent of those units. Because the research would take place over in several tributaries in the Lower Sacramento River, the potential losses cannot be ascribed to any population for any species or we currently do not have population data for the research tributary and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Because the action area falls entirely within designated critical habitat and navigable marine waters, the vast majority of future actions in the region will undergo section 7 consultation with one or more of the Federal entities with regulatory jurisdiction over water quality, habitat management, flood management, navigation, or hydroelectric generation. In almost all instances, proponents of future actions will need government funding or authorization to carry out a project that may affect salmonids, sturgeon, rockfish, eulachon, or their habitat, and therefore the effects such a project may have on listed species will be analyzed when the need arises.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the species status/environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the status section (Section 2.2).

In developing this biological opinion, we considered several efforts being made at the local, tribal, state, and national levels to conserve listed species—primarily final recovery plans and efforts laid out in the Status review updates for Pacific salmon and steelhead listed under the Endangered Species Act.[4] The recovery plans, status summaries, and limiting factors that are part of the analysis of this Opinion are discussed in detail in Table 2 (Section 2.2.1).

The result of that review was that salmon take—particularly take associated with monitoring and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation (like that in this opinion) before they are allowed to proceed.

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could affect listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities, make any analysis of cumulative effects difficult and speculative. For more information on the various efforts being made at the local, tribal, state, and national levels to conserve PS Chinook salmon and other listed salmonids, see any of the recent status reviews, listing Federal Register notices, and recovery planning documents, as well as recent consultations on issuance of section 10(a)(1)(A) research permits.

Thus, non-Federal activities are likely to continue affecting listed species and habitat within the action area. These cumulative effects in the action area are difficult to analyze because of this opinion's large geographic scope, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, it seems likely that they will continue to increase as a general pattern over time. The primary cumulative effects will arise from those water quality and quantity impacts that occur as human population growth and development shift patterns of water and land use, thereby creating more intense pressure on streams and rivers within this geography in terms of volume, velocities, pollutants, baseflows, and peak flows. But the specifics of these effects, too, are impossible to predict at this time. In addition, there are the aforementioned effects of climate change—many of those will arise from or be exacerbated by actions taking place in the Pacific Northwest and elsewhere that will not undergo ESA consultation. Although many state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

We can, however, make some generalizations based on population trends.

Puget Sound/Western Washington

Non-Federal actions are likely to continue affecting listed species. The cumulative effects in this portion of the action area are difficult to analyze because of this opinion's geographic scope, however, based on the trends identified in the baseline, the adverse cumulative effects are likely to

[4] NOAA Fisheries – West Coast Region - 2016 Status Reviews of Listed Salmon & Steelhead

increase. From 1960 through 2016, the population in Puget Sound has increased from 1.77 to 4.86 million people (Source: WA state Office of Financial Management homepage). During this population boom, urban land development has eliminated hydrologically mature forest and undisturbed soils resulting in significant change to stream channels (altered stream flow patterns, channel erosion) which eventually results in habitat simplification (Booth et al. 2002). Combining this population growth with over a century of resource extraction (logging, mining, etc.), Puget Sound's hydrology has been greatly changed and has created a different environment than what Puget Sound salmonids evolved in (Cuo et al. 2009). Scholz et al. (2011) has documented adult coho salmon mortality rates of 60-100% for the past decade in urban central Puget Sound streams that are high in metals and petroleum hydrocarbons especially after stormwater runoff. In addition, marine water quality factors (e.g. climate change, pollution) are likely to continue to be degraded by various human activities that will not undergo consultation. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects. Thus, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

Idaho and Eastern Oregon and Washington

According to the U.S. Census bureau, the State of Idaho's population has been increasing at about 1% per year over the last several years, but that increase has largely been confined to the State's urban areas. The rural population—the areas where the proposed actions would take place--saw a 14% decrease in population between 1990 and 2012.[5] This signifies that in the action areas, if this trend continues, there is likely to be a reduction in competing demands for resources such as water. Also, it is likely that streamside development will decrease. However, given the overall increase in population, recreation demand for resources such as the fish themselves may go up—albeit slowly.

The situation is similar for Eastern Oregon and Washington. Both states have seen population increases between 0.5% and 1.5% per year for Oregon between 2000 and 2010,[6] an overall 12% for Washington between 2000 and 2010, and a 2.7% increase for rural, eastern Oregon for the past five years (2013-2018).[7] And, though Eastern Washington has also seen some population increase, it has largely been restricted to the population centers rather than the rural areas.[8] This signifies that, as with Idaho, there is little likelihood that there will be increasing competing demands for primary resources like water, but recreational demand for the species themselves will probably increase along with the human population.

Western Oregon

The situation in Western Oregon is likely to be similar to that of the Puget Sound region: cumulative effects are likely to continue increasing both in the Willamette valley and along the coast, with nearly all counties showing year-by-year population increases of about 0.5% to 1.5% over the last

[5] Idaho State Journal June 2, 2013 "Idaho's rural population continues to shrink"
[6] Portland State University "Annual Oregon Population Report"
[7] State of Oregon Employment Department Dec 20, 2018 "A Quick Look at Population Trends in Eastern Oregon"
[8] Cashmere Valley Record March 9, 2011 "Population growth slowed during last decade, but state is more diversified"

several years.[6] The result of this growth is that there will be more development and therefore more habitat impacts such as simplification, hydrologic effects, greater levels of pollution (in the Willamette Valley), other water quality impacts, soil disturbance, etc. These effects would be somewhat lessened in the coastal communities, but resource extraction (particularly timber harvest) would probably continue to increase slightly. Though once again, most such activities, whether associated with development or extraction, would undergo formal consultation if they were shown to take place in (or affect) critical habitat or affect listed species. Thus, it is difficult to characterize the effects that would not be consulted upon beyond saying they are likely to increase both in severity and in geographic scope.

One final thing to take into account when considering cumulative effects is the time period over which the activity would operate. The permits considered here would be good for a maximum of five years and the effects on listed species abundance they generate could continue for up to four years after that, though they would decrease in each succeeding year. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that timeframe.

California

According to the U.S. Census Bureau, the State of California's population increased 6.1% from 2010 to 2019 (source: Census Bureau California Quick Facts). If this trend in population growth continues, there will be an increase in competing demands for water resources. Water withdrawals, diversions, and other hydrological modifications to regulate water bodies are likely to continue. Urbanization and rural development are limiting factors for many of the listed salmonids within the State of California and these factors are likely to increase with continued population growth. Therefore, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

One final thing to take into account when considering cumulative effects is the time period over which the activity would operate. The permits considered here would be good for a maximum of five years and the effects on listed species abundance they generate could continue for up to four years after that, though they would decrease in each succeeding year. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that timeframe.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), while taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

Aside from the considerations listed above, these assessments are also made in consideration of the other research that has been authorized and that may affect the various listed species. The reasons we integrate the proposed take in the permits considered here with the take from previous (but ongoing) research authorizations are that they are similar in nature and we have good information on what the effects are, and thus it is possible to determine the overall effect of all research in the region on the species considered here. The following two tables therefore (a) combine the proposed take for all the permits considered in this opinion for all components of each species (Table 67), (b) add that take to the take that has already been authorized in the region and (c) compare those totals to the estimated annual abundance of each species under consideration (Table 68).

Table 67. Total requested take for the permits and percentages of the ESA listed species for permits covered in this Biological Opinion.

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	10	1	0.047	0.005
		Listed Hatchery Intact Adipose	10	1	0.111	0.011
		Listed Hatchery Adipose Clip	10	1		
	Juvenile	Natural	2,000	122	0.063	0.004
		Listed Hatchery Intact Adipose	1,655	118	0.022	0.002
		Listed Hatchery Adipose Clip	1,485	120	0.003	<0.001
Puget Sound Steelhead	Juvenile	Natural	586	13	0.027	<0.001
		Listed Hatchery Intact Adipose	513	10	0.456	0.009

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	513	10	0.466	0.009
Puget Sound/Georgia Basin DPS Bocaccio[a]	Juvenile	Natural	10	2	0.217	0.043
Puget Sound/Georgia Basin DPS yelloweye rockfish[a]	Juvenile	Natural	10	2	0.015	0.003
Hood Canal summer-run chum salmon	Juvenile	Natural	105	18	0.003	<0.001
		Listed Hatchery Intact Adipose	115	18	0.077	0.012
		Listed Hatchery Adipose Clip	85	18	-	-
Upper Columbia River spring-run Chinook salmon	Juvenile	Natural	60	2	0.013	<0.001
		Listed Hatchery Intact Adipose	10	0	0.003	0.000
		Listed Hatchery Adipose Clip	20	1	0.003	<0.001
Upper Columbia River Steelhead	Juvenile	Natural	12	1	0.006	<0.001
		Listed Hatchery Intact Adipose	2	0	0.001	0.000
		Listed Hatchery Adipose Clip	2	0	<0.001	0.000

Species	**Life Stage**	**Origin**	**Requested Take**	**Lethal Take**	**Percent of ESU/DPS taken**	**Percent of ESU/DPS killed**
Middle Columbia River Steelhead	Juvenile	Natural	30,362	704	7.447	0.173
		Listed Hatchery Intact Adipose	-498	-16	-0.451	-0.014
		Listed Hatchery Adipose Clip	2	0	<0.001	0.000
Snake River spring/summer-run Chinook salmon	Juvenile	Natural	20	2	0.002	<0.001
		Listed Hatchery Adipose Clip	2	2	<0.001	<0.001
Snake River fall-run Chinook salmon	Adult	Natural	10	0	0.097	0.000
		Listed Hatchery Adipose Clip	5	0	0.032	0.000
	Juvenile	Natural	75	3	0.011	<0.001
		Listed Hatchery Intact Adipose	10	0	<0.001	0.000
		Listed Hatchery Adipose Clip	25	1	0.001	<0.001
Snake River Basin Steelhead	Adult	Natural	75	1	0.711	0.009
	Juvenile	Natural	72	3	0.009	<0.001
		Listed Hatchery Intact Adipose	2	0	<0.001	0.000
		Listed Hatchery Adipose Clip	2	0	<0.001	0.000

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River sockeye salmon	Juvenile	Natural	2	0	0.010	0.000
		Listed Hatchery Adipose Clip	2	0	<0.001	0.000
Lower Columbia River Chinook salmon	Adult	Natural	51	2	0.173	0.007
		Listed Hatchery Adipose Clip	51	2	0.132	0.005
	Juvenile	Natural	70	2	<0.001	<0.001
		Listed Hatchery Intact Adipose	10	0	0.001	0.000
		Listed Hatchery Adipose Clip	20	1	<0.001	<0.001
Lower Columbia River coho salmon	Adult	Natural	600	6	2.009	0.020
		Listed Hatchery Adipose Clip	200	4	2.275	0.046
	Juvenile	Natural	40	2	0.006	<0.001
		Listed Hatchery Intact Adipose	5	0	0.002	0.000
		Listed Hatchery Adipose Clip	10	0	<0.001	0.000
Lower Columbia River Steelhead	Adult	Natural	1,040	11	8.050	0.085
		Listed Hatchery Adipose Clip	50	2	0.224	0.009

Species	**Life Stage**	**Origin**	**Requested Take**	**Lethal Take**	**Percent of ESU/DPS taken**	**Percent of ESU/DPS killed**
	Juvenile	Natural	22	1	0.006	<0.001
		Listed Hatchery Intact Adipose	2	0	0.022	0.000
		Listed Hatchery Adipose Clip	2	0	<0.001	0.000
Columbia River chum salmon	Adult	Natural	20	1	0.188	0.009
	Juvenile	Natural	20	1	<0.001	<0.001
		Listed Hatchery Intact Adipose	5	0	<0.001	0.000
		Listed Hatchery Adipose Clip	10	0	-	-
Upper Willamette River Chinook salmon	Juvenile	Natural	2,540	27	0.210	0.002
		Listed Hatchery Intact Adipose	20	1	0.475	0.024
		Listed Hatchery Adipose Clip	40	1	<0.001	<0.001
Upper Willamette River Steelhead	Juvenile	Natural	2,424	25	1.727	0.018
Oregon Coast coho salmon	Juvenile	Natural	970	17	0.015	<0.001
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	28	6	0.309	0.066
		Listed Hatchery Intact Adipose	16	6	0.265	0.073

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	13	2		
	Juvenile	Natural	48,441	1,040	2.406	0.052
		Listed Hatchery Intact Adipose	48	48	0.008	0.008
		Listed Hatchery Adipose Clip	11	11	0.006	0.006
Northern California Steelhead	Adult	Natural	218	7	3.019	0.097
	Juvenile	Natural	56,860	1,685	6.922	0.205
California Coastal Chinook salmon	Adult	Natural	56	10	0.796	0.142
	Juvenile	Natural	8,489	227	0.664	0.018
Sacramento River winter-run Chinook salmon	Adult	Natural	1,362	9	648.571	4.286
		Listed Hatchery Adipose Clip	1,332	6	59.677	0.269
	Juvenile	Natural	416,546	11,174	213.226	5.720
		Listed Hatchery Intact Adipose	4	0	-	-
		Listed Hatchery Adipose Clip	196,660	5,983	98.330	2.992
Central Valley spring-run Chinook salmon	Adult	Natural	1,107	5	29.702	0.134
		Listed Hatchery Adipose Clip	95	23	4.179	1.012

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Juvenile	Natural	391,897	11,828	50.536	1.525
		Listed Hatchery Adipose Clip	627	319	0.029	0.015
California Central Valley Steelhead	Adult	Natural	872	38	51.720	2.254
		Listed Hatchery Adipose Clip	92	11	2.386	0.285
	Juvenile	Natural	35,866	1,292	5.689	0.205
		Listed Hatchery Adipose Clip	15,487	674	0.968	0.042
Central California Coast coho salmon	Adult	Natural	17	2	0.880	0.104
		Listed Hatchery Intact Adipose	5	2	1.529	0.612
	Juvenile	Natural	13,774	417	8.711	0.264
		Listed Hatchery Intact Adipose	16	16	0.010	0.010
Central California Coast Steelhead	Adult	Natural	19	5	0.869	0.229
		Listed Hatchery Adipose Clip	5	5	0.129	0.129
	Juvenile	Natural	4,318	214	1.736	0.086
		Listed Hatchery Adipose Clip	1	1	<0.001	<0.001
	Adult	Natural	262	6	37.698	0.863

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
South-Central California Coast Steelhead	Juvenile	Natural	19,858	594	25.119	0.751
Southern California Steelhead	Adult	Natural	12	0	-[b]	-[b]
	Juvenile	Natural	8	0		
Southern DPS Eulachon[a]	Adult	Natural	160	6	<0.001	<0.001
	Juvenile	Natural	60	4		
Southern DPS green sturgeon	Adult	Natural	52	1	2.469	0.047
	Juvenile	Natural	1,441	62	32.847	1.413
	Larvae	Natural	11,000	1,000	-	-
	Egg	Natural	1,250	1,250		

[a]Abundance for these species are only known for the adult life stage which is used to represent the entire DPS.

[b] We do not have any reliable abundance numbers for either adults or juveniles for this species.

Thus, the activities contemplated in this opinion may kill—in combination and at most—as much as 5.27% of the fish from any component of any listed species; that component is natural juvenile SacR Chinook. It should be noted, however, that the great majority of these fish would appear in Permit 1415, and this work has been going on for decades and always been found not to jeopardize the species. Moreover, and as previously noted, over the past five years, the researchers associated with Permit 1415 have only taken 3.44% of their requested take and killed 4.63% of the requested mortalities, so it is most likely that the actual effect will be less than one-twentieth of that displayed. In all other species found in the table above, the effect is (at most) about one-fifth of the 5.27% figure and, in the majority of cases, the effect is orders of magnitude smaller. And these figures are probably much lower in actuality, but before engaging in that discussion, it is necessary to add all the take considered in this opinion to the rest of the research take that has been authorized on the West Coast.

Table 68. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2021 plus the permits covered in this Biological Opinion.

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Adult	Natural	859	34	3.998	0.158

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon		Listed Hatchery Intact Adipose	937	10	11.561	0.388
		Listed Hatchery Adipose Clip	1,151	60		
	Juvenile	Natural	388,621	8,676	12.284	0.274
		Listed Hatchery Intact Adipose	86,433	2,966	1.157	0.040
		Listed Hatchery Adipose Clip	207,705	11,012	0.438	0.023
Puget Sound Steelhead	Adult	Natural	1,814	39	9.611	0.236
		Listed Hatchery Intact Adipose	22	0		
		Listed Hatchery Adipose Clip	34	7		
	Juvenile	Natural	45,796	1,124	2.072	0.051
		Listed Hatchery Intact Adipose	2,309	38	2.052	0.034
		Listed Hatchery Adipose Clip	5,265	111	4.786	0.101
Puget Sound/Georgia[a] Basin DPS bocaccio	Adult	Natural	38	21	2.518	1.086
	Subadult	Natural	2	1		
	Juvenile	Natural	76	28		
Puget Sound/Georgia[a] Basin DPS yelloweye rockfish	Adult	Natural	40	22	0.140	0.076
	Subadult	Natural	2	1		
	Juvenile	Natural	52	28		
Hood Canal summer-run chum salmon	Adult	Natural	2,007	31	7.981	0.123
	Juvenile	Natural	726,913	2,551	18.687	0.066
		Listed Hatchery Intact Adipose	250	21	0.167	0.014
		Listed Hatchery Adipose Clip	85	18	-	-

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Columbia River spring-run Chinook salmon	Adult	Natural	223	6	7.765	0.209
		Listed Hatchery Intact Adipose	150	3	4.459	0.089
		Listed Hatchery Adipose Clip	168	7	2.698	0.112
	Juvenile	Natural	10,796	231	2.303	0.049
		Listed Hatchery Intact Adipose	1,034	33	0.280	0.009
		Listed Hatchery Adipose Clip	1,484	68	0.239	0.011
Upper Columbia River Steelhead	Adult	Natural	235	4	12.170	0.207
		Listed Hatchery Intact Adipose	94	2	8.083	0.172
		Listed Hatchery Adipose Clip	219	6	4.125	0.113
	Juvenile	Natural	32,233	663	16.167	0.333
		Listed Hatchery Intact Adipose	2,418	69	1.745	0.050
		Listed Hatchery Adipose Clip	10,334	248	1.503	0.036
Middle Columbia River Steelhead	Adult	Natural	1,432	20	28.345	0.396
		Listed Hatchery Intact Adipose	169	6	150.893	5.357
		Listed Hatchery Adipose Clip	933	12	208.259	2.679
	Juvenile	Natural	115,045	2,539	28.218	0.623
		Listed Hatchery Intact Adipose	8,682	116	7.859	0.105
		Listed Hatchery Adipose Clip	900	43	0.202	0.010
	Adult	Natural	1,907	15	14.901	0.117

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Snake River spring/summer-run Chinook salmon		Listed Hatchery Intact Adipose	386	3	91.686	0.713
		Listed Hatchery Adipose Clip	1,256	9	52.618	0.377
	Juvenile	Natural	764,061	7,192	75.835	0.714
		Listed Hatchery Intact Adipose	45,827	424	5.911	0.055
		Listed Hatchery Adipose Clip	84,529	1,189	1.898	0.027
Snake River fall-run Chinook salmon	Adult	Natural	261	11	2.525	0.106
		Listed Hatchery Intact Adipose	213	2	1.572	0.015
		Listed Hatchery Adipose Clip	262	15	1.689	0.097
	Juvenile	Natural	2,053	115	0.296	0.017
		Listed Hatchery Intact Adipose	337	35	0.012	0.001
		Listed Hatchery Adipose Clip	841	140	0.034	0.006
Snake River Basin Steelhead	Adult	Natural	8,068	109	76.496	1.033
		Listed Hatchery Intact Adipose	2,279	36	14.123	0.223
		Listed Hatchery Adipose Clip	2,920	46	3.672	0.058
	Juvenile	Natural	290,317	3,672	36.365	0.460
		Listed Hatchery Intact Adipose	33,874	367	4.801	0.052
		Listed Hatchery Adipose Clip	78,739	909	2.386	0.028
Snake River sockeye salmon	Adult	Natural	11	4	2.015	0.733
		Listed Hatchery Intact Adipose	1	0	-	-

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	1	0	0.025	0.000
	Juvenile	Natural	10,580	462	55.159	2.409
		Listed Hatchery Intact Adipose	1	0	-	-
		Listed Hatchery Adipose Clip	391	260	0.161	0.107
Lower Columbia River Chinook salmon	Adult	Natural	326	16	1.106	0.054
		Listed Hatchery Intact Adipose	12	0	0.422	0.034
		Listed Hatchery Adipose Clip	151	13		
	Juvenile	Natural	768,189	10,586	6.541	0.090
		Listed Hatchery Intact Adipose	315	36	0.033	0.004
		Listed Hatchery Adipose Clip	53,857	1,565	0.172	0.005
Lower Columbia River coho salmon	Adult	Natural	1,423	18	4.765	0.060
		Listed Hatchery Intact Adipose	31	0	7.280	0.466
		Listed Hatchery Adipose Clip	609	41		
	Juvenile	Natural	180,058	2,553	27.221	0.386
		Listed Hatchery Intact Adipose	560	112	0.224	0.045
		Listed Hatchery Adipose Clip	53,496	1,855	0.734	0.025
Lower Columbia River Steelhead	Adult	Natural	2,834	32	21.935	0.248
		Listed Hatchery Adipose Clip	86	4	0.386	0.018
	Juvenile	Natural	68,527	1,176	19.460	0.334

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Intact Adipose	3	0	0.033	0.000
		Listed Hatchery Adipose Clip	40,946	615	3.420	0.051
Columbia River chum salmon	Adult	Natural	40	6	0.376	0.056
		Listed Hatchery Intact Adipose	1	0	0.235	0.000
	Juvenile	Natural	39,184	501	0.591	0.008
		Listed Hatchery Intact Adipose	567	18	0.094	0.003
		Listed Hatchery Adipose Clip	10	0	-	-
Upper Willamette River Chinook salmon	Adult	Natural	206	6	2.019	0.059
		Listed Hatchery Adipose Clip	171	13	0.543	0.041
	Juvenile	Natural	46,792	722	3.861	0.060
		Listed Hatchery Intact Adipose	46	4	1.092	0.095
		Listed Hatchery Adipose Clip	8,720	278	0.185	0.006
Upper Willamette River Steelhead	Adult	Natural	227	4	7.795	0.137
	Juvenile	Natural	14,147	254	10.076	0.181
Oregon Coast coho salmon	Adult	Natural	7,568	118	8.024	0.125
		Listed Hatchery Adipose Clip	21	4	3.757	0.716
	Juvenile	Natural	529,830	12,079	7.977	0.182
		Listed Hatchery Adipose Clip	284	20	0.473	0.033
Southern Oregon/Northern	Adult	Natural	1,654	23	18.246	0.254
		Listed Hatchery Intact Adipose	1,811	10	22.078	0.210

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
California Coast coho salmon		Listed Hatchery Adipose Clip	603	13		
	Juvenile	Natural	197,545	2,897	9.811	0.144
		Listed Hatchery Intact Adipose	7,619	645	1.325	0.112
		Listed Hatchery Adipose Clip	3,949	75	1.974	0.037
Northern California Steelhead	Adult	Natural	943	24	13.059	0.332
	Juvenile	Natural	222,257	3,206	27.059	0.390
California Coastal Chinook salmon	Adult	Natural	531	25	7.549	0.355
	Juvenile	Natural	294,263	3,778	23.024	0.296
Sacramento River winter-run Chinook salmon	Adult	Natural	1,520	24	723.810	11.429
		Listed Hatchery Adipose Clip	1,515	51	67.876	2.285
	Juvenile	Natural	428,766	11,524	219.482	5.899
		Listed Hatchery Intact Adipose	4	0	-	-
		Listed Hatchery Adipose Clip	205,255	7,545	102.627	3.772
Central Valley spring-run Chinook salmon	Adult	Natural	1,573	26	42.206	0.698
		Listed Hatchery Adipose Clip	673	82	29.608	3.608
	Juvenile	Natural	878,546	17,197	113.291	2.218
		Listed Hatchery Adipose Clip	18,566	3,455	0.856	0.159
California Central Valley Steelhead	Adult	Natural	3,978	98	235.943	5.813
		Listed Hatchery Adipose Clip	2,276	100	59.025	2.593
	Juvenile	Natural	64,712	1,922	10.265	0.305
		Listed Hatchery Adipose Clip	26,127	1,704	1.632	0.106

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central California Coast coho salmon	Adult	Natural	3,418	52	176.915	2.692
		Listed Hatchery Intact Adipose	1,655	35	506.116	10.703
	Juvenile	Natural	189,781	3,529	120.016	2.232
		Listed Hatchery Intact Adipose	84,406	1,969	50.884	1.187
Central California Coast Steelhead	Adult	Natural	2,426	48	110.928	2.195
		Listed Hatchery Adipose Clip	492	17	12.726	0.440
	Juvenile	Natural	232,794	5,273	93.578	2.120
		Listed Hatchery Intact Adipose	6,200	124	-	-
		Listed Hatchery Adipose Clip	12,881	355	1.985	0.055
South-Central California Coast Steelhead	Adult	Natural	1,240	12	178.417	1.727
	Juvenile	Natural	37,256	812	47.125	1.027
Southern California Steelhead	Adult	Natural	67	8	-[b]	-
	Juvenile	Natural	21,498	583		
Southern DPS Eulachon[a]	Adult	Natural	33,711	31,053	0.110	0.102
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	540	456		
Southern DPS green sturgeon	Adult	Natural	516	13	24.501	0.617
	Subadult	Natural	81	6	0.733	0.054
	Juvenile	Natural	1,760	73	40.119	1.664
	Larvae	Natural	11,010	1,010	-	-
	Egg	Natural	1,250	1,250		

[a]Abundance for these species are only known for the adult life stage which is used to represent the entire DPS.

[b] We do not have any reliable abundance numbers for either adults or juveniles for this species.

As the table above illustrates, in many cases the dead fish from all of the permits in this opinion and all the previously authorized research would amount to a less than half a percent of each species' total abundance. In these instances, the total mortalities are so small and so spread out across each listed unit that they are unlikely to have any lasting detrimental effect on the species' numbers, reproduction, or distribution.

However, in 26 cases involving 14 species, the total potential mortality could amount to a more substantial percentage of an ESU component (i.e., life stage and origin). As a result, we will review the potential mortality in these instances in more detail.

2.7.1 Salmonid Species

As Tables 67 and 68 illustrate, in most instances, the research—even in total—would have only very small effects on any species' abundance (and therefore productivity) and no discernible effect on structure or diversity because the effects would be attenuated across each entire species. Nonetheless, there are some instances where closer scrutiny of the effects on a particular component is warranted. The newly proposed research, when considered with research already authorized would potentially kill more than one half of one percent of the estimated abundance of an adult or juvenile component of the following listed species: MCR steelhead, SnkR spr/sum Chinook, SnkR sockeye, SnkR steelhead, OC coho, SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, CCC coho salmon, CCC steelhead, SCCC steelhead, and SC steelhead. Detailed descriptions of these effects for juveniles and adults follow in the paragraphs below.

A few considerations apply generally to our analyses of the total mortalities that would be permitted for juveniles and adults of each of these species (Table 68). First, we do not expect the potential mortality of adipose-fin-clipped, hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild because, while they are listed, they are considered surplus to recovery needs. We therefore focus primarily on the naturally produced ESU or DPS components.

Second, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. We develop conservative estimates of abundance, as described in Section 2.2. As noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur. It is therefore very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. The degree to which these values are likely overestimates, based on actual reported data from recent years of the research program, is discussed for each species and age class in the following sub sections and in the effects section.

Another reason effects on natural-origin components of each listed unit may be smaller than the values in the tables above is how we ask researchers to report taken fish of unknown origin. In those instances where a non-clipped hatchery fish cannot be differentiated from a natural-origin fish, we ask that researchers err to the side of caution and treat all fish with intact adipose fins as if they were natural-origin fish. So for instance, given that for the MCR steelhead, unclipped hatchery fish make up approximately 39% of the animals with intact adipose fins, it is undoubtedly the case that some unclipped fish would be taken and counted as natural-origin fish. Therefore, in most cases, the natural-origin component would in actuality be affected to a lesser degree than the percentages displayed above. It is not possible to know *how much* smaller the take figures would be, but that they are smaller is not in doubt. The overall percentages for the listed unit would, however, remain at the same low levels shown.

Lastly, the research being conducted in the region adds critical knowledge about the species' status—knowledge that we are required to have every five years to perform status reviews for all listed species. So in evaluating the impacts of the research program, any effects on abundance and productivity are weighed in light of the potential value of the information collected as a result of the research. Regardless of its relative magnitude, the negative effects associated with the research program on these species would to some extent be offset by gaining information that would be used to help the species survive and recover.

As described in further detail below, because we found for each ESU and DPS that . . .

1. The research activities' expected detrimental effects on the species' abundance and productivity would be small, even in combination with all the rest of the research authorized in the region; and
2. That slight impact would be distributed throughout the species' entire range and would therefore be so attenuated as to have no appreciable effect on spatial structure or diversity.

. . . we determined that the impact of the research program—even in its entirety—would be restricted to a small effect on abundance and productivity and that the activities analyzed here would add only a small increment to that impact. Also, and again, those small effects the research program has on abundance and productivity are offset to some degree by the beneficial effects the program as a whole generates in fulfilling a critical role in promoting the species' health by producing information managers need to help listed species recover.

Juveniles

The newly proposed research would, in combination with mortalities already authorized for research in the region, necessitate further discussion of potential effects on juvenile MCR steelhead, SnkR spr/sum Chinook, SnkR Sockeye, SacR WR Chinook salmon, CVS Chinook salmon, CCC coho salmon, CCC steelhead, SCCC steelhead, and SC steelhead (see end of "Adults" section, below, for both life stages of SC steelhead).

For all of these ESUs and DPSs, the majority of the stated take in Table 68 has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. In addition for these species, the effects from the activities contemplated in this opinion were found to incur losses that are very small, the effects are only seen in reductions in abundance and productivity and, as described above, the estimates of mortalities are almost certainly much greater than the actual numbers are likely to be. Data from our tracking system demonstrates that for the research program as a whole, over the past five years (2015-2019) researchers only actually killed about 12% of the juvenile fish they were allotted as authorized mortalities (and only 9.7% of natural-origin mortalities). This means that the take levels for juveniles are likely to actually be something on the order of one tenth of the numbers displayed in the tables above. Still, even in the worst case scenario (which assumes that all authorized mortalities would occur), for all ESUs and DPSs the effects would be small and restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery. The specific circumstances of each ESU and DPS warranting further evaluation are discussed in detail below.

Middle Columbia River Steelhead

A figure requiring a closer view is the 0.623% of the natural-origin MCR steelhead juveniles killed by research activities in the Deschutes River basin. The actions considered in this opinion would appear to add 704 fish to the total being allotted, but in fact the great majority (>600) of those additional fish come from either permit renewals or the Deschutes River NEP (which are considered excess to the DPS's recovery needs). Thus, the 0.623% actually represents little increase in an amount of take that has previously been found to not jeopardize the species.

Out of an abundance of caution, we analyze the effect of removing juveniles from the NEP as if they were part of the listed unit, but in fact it will be four years until they are actually considered to be part of the MCR steelhead DPS. Still, if the all the fish that are permitted to be taken were to be taken in fact, it would likely result in small but measurable abundance and productivity losses for the DPS.

However, it should also be noted that for the last five years, the yearly average amount of natural MCR steelhead juvenile taken is only 24.2% of what has been permitted—and the average mortality rate has averaged only 11% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably around a tenth of the figure displayed. And in any case, the losses would be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect. The impact of the program—even in its entirety—is thus a very small effect on abundance and productivity, the activities analyzed here would add little increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR spr/sum Chinook salmon

Under the research program as a whole, 0.714% of the natural-origin juvenile SnkR spr/sum Chinook salmon may be killed in a given year. While it should be noted that this figure actually represents an increase of only two fish over the baseline take, it is still means that about seven juvenile natural-origin fish out of every thousand may be killed every year by the research efforts in the basin. However, this minor effect has repeatedly been determined to not jeopardize the species, the information being generated is used in critical status monitoring and recovery. Also, in the approximately 20 years that the primary permits taking these fish has been in effect (Permits 1127, Permit 1134, and Permit 1339—the first held by the Shoshone-Bannock, the other two held by the Nez Perce Tribes) the researchers have never killed more than 70% of fish they were allotted; and in most years, the total mortalities were far less than 50% of the permitted amounts. This is also true for the research that the IDFG conducts under other authorizations—they generally take less than 70% of what they are allotted and kill even less than that.

In any case, when the losses of this component generated by the program as a whole are considered in the context of the entire listed unit instead of simply the natural-origin component, the mortality rate is actually on the order of 0.10% in even the most pessimistic scenario, which, though not negligible, is still a very small impact. Finally, majority of the research considered here in this opinion (as well as the permits and the IDFG research mentioned above) is critical for determining the status of this species every year.

Snake River Sockeye Salmon

Another effect on juvenile fish requiring further scrutiny is the 2.409% mortality rate for natural-origin SnkR sockeye salmon. While this figure should be viewed with caution, there are two important caveats associated with the mortality numbers: many of the fish that are listed as "natural" would in actuality probably be hatchery fish (of which there are 10 times as many), but they are considered "natural" for the purposes of this analysis in order to lay out the worst-case scenario associated with the research. Second, these truly are worst-case numbers. Over the last 10 years, the IDFG researchers under Permit 1124 (the main permit under which sockeye salmon are taken) have killed less than 20% of the permitted mortalities. That is also true for the other main permit under which this species is taken: Permit 1341 is held by the Shoshone-Bannock tribes and over the last five years they have killed, in total, less than 10% of the natural-origin juvenile sockeye salmon they have been permitted. As a result, the total mortality rate for the program is probably on the order of 0.2% to 0.4% rather than the 2.4% displayed. And while it is true that when the juvenile mortality rates are considered in the context of the species as a whole, the rate drops to about 0.27%, the potential loss of roughly 2.4% of any component of a listed species is a number to be wary of—even though in this case (and as noted above), some fraction of that 2.4% would actually be hatchery fish rather than natural-origin fish. Still, the research program as a whole could have a small effect on the species abundance and productivity—but not on structure or diversity given that there is only one population and it is largely upheld by hatchery actions.

So the 2.4% figure is one that bears careful consideration. However, in this instance, it is necessary to emphasize two things: First, the take contemplated in this opinion actually adds no fish at all to the baseline, so all of that 2.4% figure has been analyzed multiple times in the past and been found not to jeopardize the species each time. Second, the entire purpose of the permit with the most juvenile SnkR sockeye salmon take (Permit 1124—held by the IDFG) is to help the sockeye salmon survive and recover. As noted previously, under that permit, the researchers support the use of captive broodstock and other methods and technology to capture, preserve, and study the few remaining sockeye salmon. It is even possible that without the research conducted under Permit 1124, the sockeye salmon might have gone extinct; and even if that is not the case, it is inarguable that the research has been critical to the recovery the sockeye salmon are starting to experience.

Sacramento River Winter Run Chinook salmon

When combined with scientific research and monitoring permits already approved the potential mortality for juvenile SacR WR Chinook salmon would range from 3.77% for hatchery-origin fish to

5.89% for naturally produced fish. The projected total lethal take for all research and monitoring activities represents a notable portion of the species' total abundance, however absolute numbers of natural-origin mortalities authorized are relatively low (11,524 juveniles; Table 68). The activities contemplated in this opinion represent a large portion of the lethal take authorized for SacR WR juveniles and this take is primarily associated with USFWS permit 1415-5R. As previously noted, a great deal of the information we have on SacR winter-run Chinook salmon in the Sacramento River comes directly from previous iterations of this research and researchers typically encounter far less fish then authorized. For this permit, over the past five years, only 5.44% (9,330 of 171,255 authorized) of the requested take and 5.06% (247 of 4,877 authorized) of the requested mortalities occurred for SacR WR Chinook salmon.

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables above. Our research tracking system reveals that over the past five years (2015-2019) researchers ended up taking on average 21% of the naturally produced SacR WR Chinook salmon juveniles they were authorized for the year, and the actual lethal take of natural-origin juveniles averaged only 12% of the mortalities authorized. This would mean that the actual effect is likely to be roughly one tenth of what is displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. So once again, the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central Valley Spring Run Chinook salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for naturally produced juvenile CVS Chinook salmon would be about 2.2% (Table 68). The activities contemplated in this opinion represent a large portion of that number. The potential mortality of CVS Chinook salmon resulting from activities contemplated in this opinion would equate to 1.52% of the abundance of natural-origin juveniles (Table 45) and this take is primarily associated with USFWS permit 1415-5R. As previously noted, a great deal of the information we have on CVS Chinook salmon in the Sacramento River comes directly from previous iterations of this research and researchers typically encounter far less fish then authorized. For this permit, over the past five years, only 12.66% (53,735 of 424,480 authorized) of the requested take and 4.7% (545 of 11,592 authorized) of the requested mortalities occurred for CVS Chinook salmon.

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables 45 and 46 above. For naturally produced CVS Chinook, our research tracking system reveals that for the past five years, researchers ended up taking on average only 5.7% of the juveniles they requested, and the actual mortality rates also averaged only 5.9% of what was requested for juveniles. This would mean that the actual effect is likely to be on the order of one-twentieth of the impact displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find that the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast coho salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile CCC coho salmon would be 2.2% for natural-origin fish and 1.2% for hatchery-origin fish (Table 68). The activities contemplated in this opinion represent only portions of those small numbers. The potential mortality for natural-origin CCC coho salmon resulting from activities contemplated in this opinion would account for only 12% of the permitted lethal take for the region (417 of the 3,529 authorized mortalities). For the hatchery component of this ESU, about 0.8% percent of the juvenile mortality (16 of 1,969 authorized mortalities) would result from activities contemplated in this opinion. Therefore, the majority of the total potential mortality for both the hatchery and natural-origin components has been previously analyzed and found not to jeopardize the species.

It is also very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the table above. Our research tracking system reveals that for the past five years, researchers ended up taking 13% of the juveniles they requested and the actual mortality was only 3.6% of the juveniles authorized to be killed. We would therefore expect that the actual mortality numbers are very likely to be less than one-twentieth of the numbers stated in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural juvenile CCC steelhead would be 2.1% of estimated species abundance (Table 68). The activities contemplated in this opinion represent only a portion of that small number. The potential mortality for natural-origin CCC steelhead resulting from activities contemplated here would account for 4% of the permitted lethal take for the region (214 of the 5,273 authorized mortalities), representing only 0.08% of the naturally produced juvenile abundance. Therefore, the great majority of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

In addition, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. Our research tracking system reveals that for the past five years, researchers ended up taking 13% of the juvenile CCC steelhead they requested and the actual mortality was only 4.0% of the juveniles authorized to be killed. This would mean that the actual effect of mortalities is likely to be on the order of one-twentieth of the effect displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile natural-origin SCCC steelhead would be 1% (Table 68). Thus the projected total lethal take for all research and monitoring activities represents a small percent of the species' total abundance, and the activities contemplated in this opinion would account for only a small fraction of that already small effect—0.7% (6 of the 812) of total authorized mortalities, representing 0.75% of the juvenile abundance of this DPS. Therefore, nearly all of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

In addition, it is likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the table above. Our research tracking system reveals that for the past five years, researchers ended up taking 17% of the juvenile naturally-produced SCCC steelhead they were authorized, and the actual mortality rate was only 3.2% of the mortalities authorized for juveniles. This would mean that the actual effect of mortalities is likely to be less than a twentieth of the effect displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Adults

For the adults, the research effects are similar to those described for the juveniles. However, killing an adult fish has a potentially much greater effect than killing a juvenile, so it is necessary to examine more closely some of those impacts. The newly proposed research would, in combination with mortalities already authorized for research in the region, necessitate further discussion of potential effects on adult MCR steelhead, SnkR steelhead, SnkR spr/sum Chinook, SnkR sockeye, OC coho, SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, CCC coho salmon, CCC steelhead, SCCC steelhead, and SC steelhead.

As with the juveniles, so few adults from any species would be killed by the new proposed research that nearly all of the stated take in Table 68 has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. For species where new adult mortalities would be authorized, effects from the activities contemplated in this opinion were found to incur losses that are very small, the effects are only seen in reductions in abundance and productivity and, as described above, the estimates of mortalities are almost certainly much greater than the actual numbers are likely to be.

Data from our tracking system demonstrates that for the research program as a whole, over the past five years (2015-2019) researchers only actually killed about 3.9% of the all the adult fish they were allotted as authorized mortalities (and only 3.2% of the permitted natural-origin mortalities). This means that the take levels for adults listed in Table 68 are likely to actually be something on the order of less than one twentieth of the numbers displayed in the tables above. Still, even in the worst case scenario assuming all authorized mortalities did occur, for all ESUs and DPSs the effects would be small and restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery. The specific circumstances of each ESU and DPS warranting further evaluation are discussed in detail below.

Middle Columbia River Steelhead

The two figures that stand out and require closer scrutiny are the 5.36% of intact adipose fish and 2.68% of the adipose-clipped fish that all the research in the region may kill, in total. While it should be noted that these figures actually represent no increase in the baseline take, it still means that as many as 2.7% adipose-clipped adult hatchery fish, and 5.4 intact-adipose fish out of every hundred would be killed every year by the research efforts in the basin. However, and for a number of reasons, these minor effects have repeatedly been determined to not jeopardize the species and, in any case, the information being generated is used in critical status monitoring and recovery efforts.

There are two main mitigating circumstances that have led to previous “no jeopardy” conclusions with regard to these levels of take. First, in the case if the intact-adipose-fin fish, the great majority of the fish being taken come from a single permit: 17306, held by the ODFW and used to monitor fish health across the Deschutes River basin. This one permit accounts for 130 out of the total 169 adult intact-adipose fish that may be killed in the research program. Moreover, all of those 130 fish are actually part of the Deschutes River NEP (see the Permit 23649 write-up above for more information)—an experimental population that is considered in its entirety to be surplus to the recovery needs of the MCR steelhead. This means that the research program as a whole may actually kill only about 1.26% of the adult, intact-adipose-fin hatchery fish. Similarly, a large number of the adipose-clipped fish that may be killed under the research program come from the NEP under Permit 17306—130 out of 933. This means that the research program may kill around 2.3% of the adult adipose-clipped MCR steelhead. Further, given that in the last five years, the ODFW has killed no adult fish of any kind under Permit 17306, these lower figures (1.26% and 2.3%) are even more likely to be representative of the program’s gross effect.

Nonetheless, if all the take represented in these two (lowered) figures were actually to occur, it would likely result in small but measurable abundance and productivity losses. These losses would be spread out across the species' entire range (so no measurable effect to structure or diversity), and they would be more acute for the intact-adipose-fin hatchery fish than for the adipose-clipped fish (even though the latter percentage is higher).

The second of the two mitigating circumstances is that, as previously noted, adipose-clipped hatchery fish are considered surplus to all species' recovery needs and, for example, are allowed to be retained in fisheries throughout the basin. They are listed under the ESA, so we must analyze any impacts on them, but the status of this adipose-fin-clipped component is such that losses of that type—some even greater than the approximately 2.3% contemplated here—have been repeatedly determined not to jeopardize *any* listed salmonids, including MCR steelhead.

Lastly, it is important to keep in mind the fact that losses of the magnitudes described are extremely unlikely to occur at all. This is illustrated by the fact that over the last five years (2015-2019), the region's researchers have taken a yearly average of about 16.5% of natural-origin adult MCR steelhead they were permitted and killed only about 6.4% of those they were permitted to lethally take (APPS permit website). This would signify that the actual mortality rates are probably a great deal less than a tenth of what is displayed.

But here again, even if the rates were as high as those in Table 68, the research being conducted in the region adds critical knowledge about the species' status. We therefore find that the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only no increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

SnkR spr/sum Chinook Salmon

Under the research program as a whole, 0.713% of the adult LHIA fish may be killed in any given year. This actually represents no increase over what has previously been authorized and has therefore repeatedly been found not to jeopardize the species. The effect is, therefore, a very small reduction in abundance and productivity. In addition, when the total adult losses are considered in the context of the entire ESU, the mortality rate drops to about 0.3%--a rate that would have no appreciable effect on diversity or structure and only a very minor and effect on abundance and productivity. Further, it should be noted that the vast majority of the take contemplated in the program as a whole comes from research being conducted by the IDFG under another authorization and research conducted under Permits 1127, 1134, and 1339 (the first held by the Shoshone-Bannock Tribe, the latter two held by the Nez Perce Tribe), the researchers have never killed more than 20% of fish they were allotted, and in most years, the total adult mortality rate was zero. And here, too, the research being carried out under these larger permits and authorizations goes directly into critical status assessments of the species in question.

Snake River Steelhead

Another take level to note is the 1.033% of the natural-origin adult SnkR basin steelhead that the research program, in its entirety, may kill. Though this figure represents an increase of only three adult fish over that which has previously been permitted, it is still means that as many as six natural-origin fish out of a thousand may be killed every year by the research efforts. However, and as noted earlier, the effects of approximately this scale have repeatedly been determined to not jeopardize the species; and the information being generated is used in critical status monitoring and recovery efforts. Thus, while the species' abundance and productivity would be affected to a slight degree, structure and diversity would almost certainly not see any measurable impact, and critical data on the species' status would continue to be generated. And, too, researchers under the permits with the largest numbers of permitted adult SnkR basin steelhead mortalities (Permit 1339, held by CRITFC; Permit 1134, held by the Shoshone-Bannock Tribe; and Idaho's Adult Weir program under various authorizations) have killed about 30 adult natural SnkR steelhead, in total, over the years spanning 2016 through 2019. Nevertheless, even if all the permitted adults from all components were actually to be killed, that would still represent only 0.18% reduction in the abundance of the species as a whole, and even that small effect would be offset to some degree by the critical status information the research program generates.

Snake River Sockeye Salmon

Even though the research considered in this opinion would add no adult sockeye salmon mortalities to the baseline take, the overall program could still kill up to 0.733% of the listed unit's adult natural-origin component. This amount has previously been shown not to jeopardize the sockeye salmon, but given the sockeye salmon's precarious status, it should still be examined. A 0.733% loss of natural adult sockeye salmon would have a small impact on abundance and therefore productivity, but no discernable impact on structure or diversity (the sockeye salmon have only one population, and it is largely upheld by a number of projects associated with a long-running artificial propagation program). Also, the mortality rate is not likely to be that high. Over the last five years, the holders of the permits with the largest amount of adult sockeye salmon take (Permit 1124 - IDFG) have killed only one adult in total, so the likely impact in a given year is probably closer to 0.036% or less. Nonetheless, even if the entire 0.733% were to be killed, the loss in abundance would be offset to some degree by the knowledge the research program provides—and in this instance the majority of the allotted take is specifically intended to support programs whose sole purpose is to help the sockeye salmon survive and recover.

Oregon Coast Coho Salmon

For OC coho salmon, the figure that stands out as needing further explanation is the 0.716% of the LHAC adults that may be killed under the program as a whole in any given year. First, none of the permits considered in this opinion would add even one fish to that total, so the magnitude of this effect has previously and repeatedly been found to not jeopardize the species' continued existence. This is because (a) the loss would have only a minor effect on abundance and productivity and no discernable impact on structure or diversity and, more importantly, (b) the impact is entirely on a component of the species that is considered surplus to recovery needs. In fact, fish from this component are the target of numerous fisheries along the Oregon coast and the four fish that all the research in total may kill in a given year represents only a fraction of the fish that are regularly harvested in Oregon every year without jeopardizing the species.

Sacramento River Winter Run Chinook Salmon

When combined with scientific research and monitoring permits already approved the potential mortality for adult SacR WR Chinook salmon would range 2.28% for hatchery-origin fish to 11.43% for naturally produced fish (Table 68). The projected total lethal take for all research and monitoring activities represents a notable portion of the species' total abundance, however absolute numbers of natural-origin mortalities authorized are low, totaling 24 adults. The activities contemplated in this opinion represent a large portion of the lethal take authorized for SacR WR adults and this take is primarily associated with USFWS permit 1415-5R. As previously noted, a great deal of the information we have on SacR winter-run Chinook salmon in the Sacramento River comes directly from previous iterations of this research and researchers typically encounter far less fish then authorized. For this project over the past five years, only 7.64% (2,805 of 36,702 authorized) of the requested take and 0% of the requested mortalities occurred for SacR WR Chinook salmon. We do not expect the potential mortality of adult hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild as these fish are considered surplus to recovery needs.

In addition, it is likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the table above. Our research tracking system reveals that over the past five years researchers ended up taking 9.0% of the naturally produced adults they requested, and the actual mortality of natural-origin adults was only 3.7% of the mortalities authorized. This would mean that the actual effect is very likely to be less than one-twentieth of the magnitude displayed in the tables above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. Because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central Valley Spring Run Chinook Salmon

When combined with scientific research and monitoring permits already approved, the potential mortality rates for adult CVS Chinook salmon would be about 0.69% for the natural component and about 3.61% of the hatchery-origin component (Table 68). The hatchery adults are considered surplus to recovery needs, therefore, we do not expect the 3.61% loss to have any genuine effect on the species' survival and recovery in the wild. The projected total lethal take for all research and monitoring activities represent a small percent of the species' natural-origin adult abundance. The activities contemplated in this opinion would constitute about 19% of that small effect (5 of the 26 authorized mortalities). The majority of the potential adult mortality has been previously analyzed and found not to jeopardize the species.

In addition, it is very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in Tables 45 and 46 above. For naturally produced CVS Chinook, our research tracking system reveals that over the past five years researchers ended up taking 4.5% of the adults they were permitted, and the actual mortality was less than 1% of the mortalities authorized for adults. This would mean that the actual effect is likely to be about on one-hundredth of the effect displayed in the table above, or near zero for adults. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

California Central Valley Steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for adult CCV steelhead would range from 2.6% to 5.8% of estimated species abundance—depending on origin (Table 68). The 5.8% potential mortality figure is for natural-origin adult fish. The hatchery-origin fish are considered surplus to recovery needs, therefore, we do not expect the loss of 2.6% of this DPS component to have any genuine effect on the species' survival and recovery in the wild.

The projected total lethal take (5.8%) for all research and monitoring activities represents a notable portion of the species' total abundance. The activities contemplated in this opinion constitute about 39% of the authorized take in the region (38 of 98 mortalities), and this take is primarily associated with USFWS permit 1415-5R. As previously noted, a great deal of the information we have on CV steelhead in the Sacramento River comes directly from previous iterations of this research and researchers typically encounter far less fish then authorized. For this project over the past five years, only 15.28% (2,038 of 13,339 authorized) of the requested take and 0% of the requested mortalities occurred for CV steelhead salmon. We do not expect the potential mortality of adult hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild as these fish are considered surplus to recovery needs.

In addition, it is very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. For naturally produced CCV steelhead, our research tracking system reveals that for the past five years (2015-2019) researchers only ended up taking 4.5% of the adults they were authorized, and the actual mortality was only 0.98% of the total mortalities authorized for adults. This would mean that the actual effect of mortalities is likely to be on the order of on one-hundredth of the effect displayed in the table above.

Thus, the losses are very small, the effects are only seen in reductions in abundance and productivity, and the estimates of adult mortalities are almost certainly much greater than the actual numbers are likely to be. And because that slight impact would be distributed throughout the entire listing units' ranges, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. Still, even in the worst case scenarios the effects are tiny, restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery.

Central California Coast Coho Salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for CCC coho salmon would range from 2.7% to 10.7% of estimated species abundance—depending on origin (Table 68). The 10.7% potential mortality figure is for adult hatchery-origin fish (which, again, are considered surplus to recovery needs and are allowed to be retained in fisheries). The total potential mortality for adult natural-origin CCC coho salmon is 2.7% of estimated species abundance. However, the activities contemplated in this opinion would authorize two additional adults mortalities which represents 0.1% of the estimated abundance of natural origin CCC coho salmon. Therefore, the majority of the total potential mortality for both the hatchery and natural-origin components has been previously analyzed and found not to jeopardize the species.

It is also very likely that researchers will take fewer fish than estimated for take that is already authorized, and that the actual effect is likely to be lower than the numbers stated in Table 68. Our research tracking system reveals that for the past five years (2015-2019) researchers ended up taking only 5.0% of natural-origin adults authorized, and the actual total number of adults killed across the research program (10 individuals over five years) was only 4.1% of the authorized natural-origin adult mortalities. We would therefore expect that the actual effects of previously authorized activities would like be on the order of one-twentieth of the effect displayed in Table 68 above, and no additional mortalities of adults would occur compared to the baseline. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would not add to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast Steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural adult CCC steelhead would be 2.195% of estimated species abundance (Table 68). The activities contemplated in this opinion represent only a portion of that small number. The potential mortality for natural-origin CCC steelhead resulting from activities contemplated here would account for 10% of the permitted lethal take for the region (5 of the 48 authorized mortalities). The great majority of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

It is also very likely that researchers will take fewer fish than estimated for take that is already authorized, and that the actual effect is likely to be lower than the numbers stated in Table 68. Our research tracking system reveals that for the past five years (2015-2019) researchers ended up taking only 3.5% of natural-origin adults authorized, and the actual total number of adults killed across the research program (four individuals over five years) was only 1.5% of the authorized natural-origin adult mortalities. We would therefore expect that the actual effects of previously authorized activities would like be on the order of one-hundredth of the effect displayed in Table 68 above, and no additional mortalities of adults would occur compared to the baseline. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would not add to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast Steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural adult SCCC steelhead would be 1.7% (Table 68). The activities contemplated here represent 50% of the permitted lethal take for the region (6 of the 12 authorized mortalities). Our research tracking system reveals that for the past five years (2015-2019) researchers have not taken or killed a single adult SCCC steelhead. It is therefore likely that the program as a whole would have essentially no impact in any given year. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Southern California Steelhead – Adults and Juveniles

As previously mentioned, we have no estimates of either juvenile or adult SC steelhead abundance. In fact, the take included in this biological opinion would help fill that data gap and, eventually help inform our analyses of effects on this ESU. The total projected lethal mortality from the program as a whole would be eight adults and 583 juvenile SC-steelhead (and the research contemplated in this opinion would add no fish at all to those totals). We do not know what percentages of the DPS these figures represent, but in no case would the permitted take be allowed to rise above a maximum of 3% even at the local level. Moreover, in all likelihood, the actual levels associated with all the research almost certain to be a great deal lower than those displayed. Our research tracking system reveals that for the past ten years, researchers ended up taking 37 percent of the adult and 9 percent of the juvenile SC steelhead they requested, and the actual mortality was 0 percent of requested for adults and only 1 percent of the requested for juveniles. This would mean that the actual effect is likely to be fractions of the numbers stated in the table above—perhaps no more than one one-hundredth of the maximum possible effect.

2.7.2 Other Species

SDPS green sturgeon

For the juvenile life-stage for SDPS green sturgeon, there is a 0.62% lethal take level authorized for adults and a 2.64% lethal take level authorized for juveniles. However, as with the salmonid species, the majority of take has already been analyzed in previous opinions and been determined not to jeopardize this DPS. The potential mortality of SDPS green sturgeon resulting from activities contemplated in this opinion would equate to only 0.11% of the juvenile abundance and 0.14% of the adult abundance (Table 45). These three adult and five juvenile mortalities would account for only 23% of the total permitted adult lethal take and 4.3% of the total permitted juvenile take for the region (13 and 116 authorized adult and juvenile mortalities, respectively; Table 68).

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables 45 and 46 above. For SDPS green sturgeon, our research tracking system reveals that for the past five years, researchers ended up lethally taking only 4.3% of the juvenile mortalities they were authorized (24/557 individuals), and have not killed one single adult (0/33). This would mean that the actual effect on juveniles is likely to be on the order of one-twentieth of the impact displayed in the tables above, and essentially zero for adult sturgeon. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. But even if in the worst case scenario all the fish authorized as mortalities were to be killed in actuality, this would represent only a small reduction in overall abundance and productivity, and because that slight impact would be distributed throughout the species' range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. And finally, regardless of its relative magnitude, all the negative effect associated with the research program on this species would to some extent be offset by gaining information that would be used to help the species survive and recover.

PS/GB Bocaccio

For all life-stages combined for PS/GB bocaccio, there is a 1.086% lethal take level authorized; however, there are reasons to believe that the impact is much lower. First, there are no lethal take requests for PS/GB bocaccio, so all of the lethal take is precautionary. Second, very few permits primarily target ESA-listed rockfish, while the majority of the permits have lethal take requests as a precaution due to their capture methods and locations (within the marine waters of Puget Sound). Third, every permit that has listed rockfish take in Puget Sound and requires depth during surveying (i.e. hook and line, trawl nets) is required to have a descending device (e.g. SeaQualizer) that can return the rockfish to their capture depth. Fourth, PS/GB bocaccio abundance is underestimated in two ways: (1) lack of a juvenile estimate and (2) adult abundance is based on an ROV estimate of a small part of their range (i.e., the marine waters around the San Juan Islands). Since we do not have a juvenile estimate for the DPS (which should be greater than the adult estimate), we treat the juveniles as adults as an overabundance of caution. This combined with using a partial estimate of adult abundance (the only estimate available) means that we overestimate the impact to the DPS. Further, bocaccio are hard to find and are rarely captured. Since 2012, PS/GB bocaccio take for the entire research program has been very low, with only five captures (all adults) and no mortalities.

Critical Habitat

As previously discussed, we do not expect the individual actions to have any appreciable effect on any listed species' critical habitat. This is true for all the proposed permit actions in combination as well: the actions' short durations, minimal intrusion, and overall lack of measureable effect signify that even when taken together they would have no discernible impact on critical habitat.

Summary

As noted earlier, no listed species currently has all its biological requirements being met. Their status is such that there must be a substantial improvement in the environmental conditions of their habitat and other factors affecting their survival if they are to begin to approach recovery. In addition, while the future impacts of cumulative effects are uncertain at this time, they are likely to continue to be negative. Nonetheless, in no case would the proposed actions exacerbate any of the negative cumulative effects discussed (habitat alterations, etc.) and in all cases the research may eventually help to limit adverse effects by increasing our knowledge about the species' requirements, habitat use, and abundance. The effects of climate change are also likely to continue to be negative. However, given the proposed actions' short time frames and limited areas, those negative effects, while somewhat unpredictable, are too small to be effectively gauged as an additional increment of harm over the time span considered in this analysis. Moreover, the actions would in no way contribute to climate change (even locally) and, in any case, many of the proposed actions would actually help monitor the effects of climate change by noting stream temperatures, flows, etc. So while we can expect both cumulative effects and climate change to continue their negative trends, it is unlikely that the proposed actions would have any additive impact to the pathways by which those effects are realized (e.g., a slight reduction in salmonid abundance would have no effect on increasing stream temperatures or continuing land development).

To this picture, it is necessary to add the increment of effect represented by the proposed actions. Our analysis shows that the proposed research activities would have slight negative effects on each species' abundance and productivity, but those reductions are so small as to have no more than a very minor effect on the species' survival and recovery. In all cases, even the worst possible effect on abundance is expected to be minor compared to overall population abundance, the activity has never been identified as a threat, and the research is designed to benefit the species' survival in the long term.

For over two decades, research and monitoring activities conducted on anadromous salmonids in the Pacific Northwest have provided resource managers with a wealth of important and useful information regarding anadromous fish populations. For example, juvenile fish trapping efforts have enabled managers to produce population inventories, PIT-tagging efforts have increased our knowledge of anadromous fish abundance, migration timing, and survival, and fish passage studies have enhanced our understanding of how fish behave and survive when moving past dams and through reservoirs. By issuing research authorizations—including many of those being contemplated again in this opinion—NMFS has allowed information to be acquired that has enhanced resource managers' abilities to make more effective and responsible decisions with respect to sustaining anadromous salmonid populations, mitigating adverse impacts on endangered and threatened salmon and steelhead, and implementing recovery efforts. The resulting information continues to improve our knowledge of the respective species' life histories, specific biological requirements, genetic make-up, migration timing, responses to human activities (positive and negative), and survival in the rivers and ocean. And that information, as a whole, is critical to the species' survival.

Additionally, the information being generated is, to some extent, legally mandated. Though no law calls for the work being done in any particular permit or authorization, the ESA (section 4(c)(2)) requires that we examine the status of each listed species every five years and report on our findings. At that point, we must determine whether each listed species should (a) be removed from the list (b) have its status changed from threatened to endangered, or (c) have its status changed from endangered to threatened. As a result, it is legally incumbent upon us to monitor the status of every species considered here, and the research program, as a whole, is one of the primary means we have of doing that.

Thus, we expect the detrimental effects on the species to be minimal and those impacts would only be seen in terms of slight reductions in juvenile and adult abundance and productivity. And because these reductions are so slight, the actions—even in combination—would have no appreciable effect on the species' diversity or structure. Moreover, we expect the actions to provide lasting benefits for the listed fish and that all habitat effects would be negligible. And finally, we expect the program as a whole and the permit actions considered here to generate information we need to fulfill our mandate under the ESA.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existences of CC, CVS, LCR, PS, SacR winter-run, SnkR fall-run, SnkR spr/sum-run, UCR spring-run, and UWR Chinook salmon; CR and HCS chum salmon; CCC, LCR, OC, and SONCC coho salmon; SnkR sockeye salmon; LCR, MCR, PS, SnkR, UCR, NC, CCV, CCC, S-CCC, SC, and UWR steelhead, S eulachon, SDPS green sturgeon, PS/GB bocaccio, and PS/GB yelloweye rockfish or destroy or adversely modify their designated critical habitats.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

In this instance, and for the actions considered in this opinion, there is no incidental take at all. The reason for this is that all the take contemplated in this document would be carried out under permits that allow the permit holders to directly take the animals in question. The actions are considered to be direct take rather than incidental take because in every case their actual purpose is to take the animals while carrying out a lawfully permitted activity. Thus, the take cannot be considered "incidental" under the definition given above.

Because the action would not cause any incidental take, we are not specifying an amount or extent of incidental take that would serve as a reinitiation trigger. Nonetheless, the amounts of direct take have been specified and analyzed in the effects section above (2.5). Those amounts—displayed in the various permits' effects analyses—constitute hard limits on both the amount and extent of take the permit holders would be allowed in a given year. Those amounts are also noted in the reinitiation clause just below because exceeding them would likely trigger the need to reinitiate consultation.

2.10 Reinitiation of Consultation

This concludes formal consultation for "The Issuance of 24 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, Idaho and California affecting Salmon, Steelhead, Eulachon, Green Sturgeon and Rockfish in the West Coast Region."

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in (1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis section (2.5) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

2.11 "Not Likely to Adversely Affect" Determination

NMFS's determination that an action "is not likely to adversely affect" listed species or critical habitat is based on our finding that the effects are expected to be discountable, insignificant, or completely beneficial (USFWS and NMFS 1998). Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are contemporaneous positive effects without any adverse effects on the species or their critical habitat.

Southern Resident Killer Whales Determination

The Southern Resident killer whale DPS was listed as endangered on February 16, 2006 (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016b). Because NMFS determined the action is not likely to adversely affect SKRWs, this document does not provide detailed discussion of environmental baseline or cumulative effects for the SRKW portion of the action area.

Several factors identified in the final recovery plan for Southern Resident killer whales may be limiting recovery including quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. It is likely that multiple threats are acting together to impact the whales. Although it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008).

Southern Resident killer whales consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008; Hanson et al. 2013; Carretta et al. 2017). During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford 2000; Krahn et al. 2002; Hauser et al. 2007; Hanson and Emmons 2010). By late fall, all three pods are seen less frequently in inland waters. In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on the Southern Resident killer whale movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months.

Southern Resident killer whales consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling from May to September indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook salmon and chum salmon are primarily contributors of the whale's diet (NWFSC unpubl. data).

Observations of whales overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2007) and collection of prey and fecal samples have also occurred in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook salmon genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpubl. data).

At the time of the last status review in 2016, there were 83 Southern Resident killer whales left in the population (NMFS 2016f). Recent estimates based on a July 2019 survey indicate Southern Residents now total approximately 73 individuals (22 in J pod, 17 in K pod, and 34 in L pod, CWR 2019). The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses for Southern Resident killer whales and a science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate (Lacy et al. 2017).

The proposed actions may affect Southern Residents indirectly by reducing availability of their preferred prey, Chinook salmon. This analysis focuses on effects to Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of Southern Resident killer whales year round, including in coastal waters, and that Chinook salmon are the preferred salmon prey species. To assess the indirect effects of the proposed action on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine distribution of Chinook salmon affected by the action, and the range of Southern Resident killer whales. We also considered the importance of the affected Chinook salmon ESUs compared to other Chinook salmon runs in Southern Resident diet composition, and the influence of hatchery mitigation programs. As described in the effects analysis for salmonids, an absolute maximum of 29,707 juvenile and 50 adult Chinook salmon may be killed during the course of the research. As the previous effects analysis illustrated, these losses—even in total—are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution for any Chinook salmon ESUs. The affected Chinook salmon species are:

- Puget Sound
- Upper Columbia River
- Snake River spring-summer run
- Snake River fall-run
- Lower Columbia River
- Upper Willamette
- California Coastal Chinook salmon
- Sacramento River winter-run Chinook salmon

- Central Valley spring-run Chinook salmon

The fact that the research would kill various Chinook salmon could affect prey availability to the whales in future years throughout their range. For the adult take, almost all of the 50 fish that could, at maximum, be killed from these ESUs would only be taken by research after they return to shallower bays, estuaries and (mostly) their natal rivers, and are therefore very unlikely to be available as prey to the whales that typically feed in coastal offshore areas. This portion of the proposed work would very probably therefore have minimal, if any, effect on prey availability for Southern Resident killer whales.

For the juveniles, the most recent ten-year average smolt-to-adult ratio (SAR) from PIT-tagged Chinook salmon returns is from the Snake River, and indicates that SARs are less than 1% (BPA 2018). If one percent of the 29,707 juvenile Chinook salmon that may be killed by the proposed research activities were otherwise to survive to adulthood, this would translate to the effective loss of about 300 adult Chinook salmon. Given that the number of adult Chinook (listed and unlisted) in the ocean at any given time is several orders of magnitude greater than that figure, it is unlikely that SRKW would intercept and feed on many (if any) of these salmon. In addition, the SRKW population must catch and eat a minimum of 1,400 salmon daily to sustain their needs (Center for Whale Research 2018). This means that the research contemplated in this opinion could kill, in its entirety and at an absolute maximum, about 21% of one day’s worth of the fish that the SRKWs need to survive. Moreover, that figure would only hold if the SRKWs could somehow intercept *all* the fish that might otherwise reach maturity without the permitted take. So even the maximum effect of a loss of 21% of one day’s worth of SRKW food could only occur under circumstances so unlikely as to effectively be impossible.

In addition, as described in Sections 2.4 and 2.5, the estimated Chinook salmon mortality is likely to be much smaller than stated. First, the mortality rate estimates for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer salmonids will be killed by the research than stated. In fact, as described in Section 2.4 according to our take tracking in the past researchers have killed between 4% and 15% of the fish they have been permitted. Thus, the actual reduction in prey that could possibly become available to the whales is probably closer to 30 than 300 fish.

Given these circumstances, and the fact that we anticipate no direct interaction between any of the researchers and the SR killer whales, NMFS finds that potential adverse effects of the proposed research on Southern Residents are insignificant and determines that the proposed action may affect, but is not likely to adversely affect, SR killer whales or their critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the habitat assessment provided by in the effects section of the opinion (2.5) and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plan developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The EFH identified within the action areas are identified in the Pacific coast salmon fishery management plan (PFMC 2014). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years).

3.2 Adverse Effects on Essential Fish Habitat

As the Biological Opinion above describes, the proposed research actions are not likely, singly or in combination, to adversely affect the habitat upon which Pacific salmon, groundfish, and coastal pelagic species, depend; the research is therefore not likely to affect EFH. All the actions are of limited duration, minimally intrusive, and are entirely discountable in terms of their effects, short-or long-term, on any habitat parameter important to the fish.

3.3 Essential Fish Habitat Conservation Recommendations

No adverse effects upon EFH are expected; therefore, no EFH conservation recommendations are necessary.

3.4 Statutory Response Requirement

Because no EFH recommendations are being made, there is no statutory response requirement.

3.5 Supplemental Consultation

The Action Agency must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the agencies listed on the first page of the preceding biological opinion. Other interested users could include all the permittees and other local and tribal interests. The document will be available within two weeks at the NOAA Library Institutional Repository. The format and naming adheres to conventional standards for style.

This ESA section 7 consultation on the issuance of the ESA section 10(a)(1)(A) research permit concluded that the actions will not jeopardize the continued existence of any species. Therefore, the funding/action agencies may carry out the research actions and NMFS may permit them. Pursuant to the MSA, NMFS determined that no conservation recommendations were needed to conserve EFH.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion [*and EFH consultation, if applicable*] contain more background on information sources and quality.
Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

5.1 Federal Register Notices

June 16, 1993 (58 FR 33212). Designated Critical Habitat; Sacramento River Winter-Run Chinook Salmon.

January 4, 1994 (59 FR 440). Endangered and Threatened Species; Status of Sacramento River Winter-run Chinook Salmon; Final Rule

October 31, 1996 (61 FR 56138). Endangered and Threatened Species; Threatened Status for Central California Coast Coho Salmon Evolutionarily Significant Unit (ESU).

March 23, 1999 (64 FR 14067). Endangered and Threatened Species; Regulations Consolidation.

May 5, 1999 (64 FR 24049). Final Rule: Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.

September 16, 1999 (64 FR 50394). Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California.

October 25, 1999 (64 FR 57399). Final Rule: Designated Critical Habitat: Revision of Critical Habitat for Snake River Spring/Summer Chinook Salmon.

June 28, 2005 (70 FR 37160). Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

September 2, 2005 (70 FR 52488). Final Rule: Endangered and Threatened Species: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California.

September 2, 2005 (70 FR 52630). Final Rule: Endangered and Threatened Species: Designated Critical Habitat: Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho.

November 18, 2005 (70 FR 69903). Final Rule: Endangered and Threatened Wildlife and Plants: Endangered Status for Southern Resident Killer Whales.

January 5, 2006 (71 FR 834). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead.

April 7, 2006 (71 FR 17757). Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon

November 29, 2006 (71 FR 69054). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for Southern Resident Killer Whale.

May 11, 2007 (72 FR 26722). Final Rule: Endangered and Threatened Species: Final Listing Determination for Puget Sound Steelhead.

February 11, 2008 (73 FR 7816). Final Rule: Endangered and Threatened Species: Final Threatened Determination, Final Protective Regulations, and Final Designation of Critical Habitat for Oregon Coast Evolutionarily Significant Unit of Coho Salmon.

October 9, 2009 (74 FR 52300). Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon.

March 18, 2010 (75 FR 13012). Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of Eulachon.

April 28, 2010 (75 FR 22276). Endangered and Threatened Wildlife and Plants: Threatened Status for the Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye and Canary Rockfish and Endangered Status for the Puget Sound/Georgia Basin Distinct Population Segment of Bocaccio Rockfish.

June 20, 2011 (76 FR 35755). Listing Endangered and Threatened Species: Threatened Status for the Oregon Coast Coho Salmon Evolutionarily Significant Unit.

October 20, 2011 (76 FR 65324). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for the Southern Distinct Population Segment of Eulachon.

April 2, 2012 (77 FR 19552). Endangered and Threatened Species; Range Extension for Endangered Central California Coast Coho Salmon.

April 14, 2014 (79 FR 20802). Final Rule: Endangered and Threatened Wildlife; Final Rule To Revise the Code of Federal Regulations for Species Under the Jurisdiction of the National Marine Fisheries Service.

November 13, 2014 (79 FR 68042). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for the Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye Rockfish, Canary Rockfish and Bocaccio.

February 11, 2016 (81 FR 7214). Final Rule: Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat.

February 11, 2016 (81 FR 7414). Final Rule: Listing Endangered and Threatened Species and Designating Critical Habitat; Implementing Changes to the Regulations for Designating Critical Habitat.

February 24. 2016 (81 FR 9252). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead.

February 19, 2019 (84 FR 4791). Endangered and Threatened Species; Take of Anadromous Fish.

March 8, 2019 (84 FR 8507). Endangered and Threatened Species; Take of Anadromous Fish.

5.2 Literature Cited

Abatzoglou, J. T., D. E. Rupp, and P. W. Mote. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. Journal of Climate. 27(5):2125-2142.

Ainslie, B. J., J. R. Post, and A. J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. North American Journal of Fisheries Management: 18(4):905-918.

Alexander, R. M. 1966. Physical aspects of swimbladder function. Biological Reviews 41:141–176.

AMIP (Adaptive Management and Implementation Plan). 2018. The FCRPS Adaptive Management and Implementation Plan (AMIP) ESU-Level Abundance and Trend Tracking Spreadsheet—updated February 2018, R. Graves pers comm.

Bartholomew, A. and J. Bohnsack. 2005. A Review of Catch-and-Release Angling Mortality with Implications for No-take Reserves. Reviews in Fish Biology and Fisheries. 15:129-154.

Beamer, E. M., R. E. McClure, and B. A. Hayman. 2000. Fiscal Year 1999 Skagit River Chinook Restoration Research. Skagit System Cooperative.

Bendock, T. and M. Alexandersdottir. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. North American Journal of Fisheries Management. 13:540-549.

Bergman, P. K., K. B. Jefferts, H. F. Fiscus, and R. C. Hager. 1968. A preliminary evaluation of an implanted, coded wire fish tag. Washington Department of Fisheries, Fisheries Research Papers. 3(1):63-84.

Booth, D. B., D. Hartley, and R. Jackson. 2002. Forest cover, impervious-surface area, and the mitigation of stormwater impacts. J Amer Water Res Assoc. 38(3):835-845.

Bordner, C. E., S. I. Doroshov, D. E. Hinton, R. E. Pipkin, R. B. Fridley, and F. Haw. 1990. Evaluation of marking techniques for juvenile and adult white sturgeons reared in captivity *In* Parker, N.C., Giorgi, A.E., Heindinger, R.C., Jester, D.B., Prince, E.D., and Winans, G.A., eds. Fish Marking Techniques, Symposium 7: American Fisheries Society, Bethesda, MD, p. 293-303.

BPA (Bonneville Power Administration). 2018. Comparative Survival Study of PIT-tagged Spring/Summer/Fall Chinook, Summer Steelhead, and Sockeye. 2018 Annual Report (12-1-2017 to 11-30-2018). BPA contract 70765, BPA Project 1996-020-00

Bruesewitz, S. L. 1995. Hook placement in steelhead. Technical Report No. AF95-01. Washington Department of Fish and Wildlife, Olympia.

Brynildson, O. M. and C. L. Brynildson. 1967. The effect of pectoral and ventral fin removal on survival and growth of wild brown trout in a Wisconsin stream. Transactions of the American Fisheries Society 96:353-355.

California HSRG (Hatchery Scientific Review Group). 2012. California hatchery review report Appendix VIII – Feather River Hatchery Spring Chinook Program Report. Prepared for the U.S. Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. Available at: Feather Spring Chinook Program Report June 2012.pdf

Center for Whale Research. 2018. Chinook Orca Survival – FACTS about Chinook Salmon. Center for Whale Research - Chinook Orca Survival webpage

CDFG (California Department of Fish and Game). 1998. A Status Review of the Spring-Run Chinook Salmon [*Oncorhynchus tshawytscha*] in the Sacramento River Drainage. Candidate Species Status Report 98-01. California Department of Fish and Game.

CDFW (California Department of Fish and Wildlife). 2012. Recovery Strategy of California Coho Salmon Progress Report 2004-2012.

CDFW (California Department of Fish and Wildlife). 2018. California Central Valley Chinook Population Database Report - GrandTab 2018.04.09. Available at: GrandTab 2018.04.09

Center for Whale Research. 2018. Chinook Orca Survival – FACTS about Chinook Salmon. Center for Whale Research - Chinook Orca Survival webpage

Chisholm, I. M. and W. A. Hubert. 1985. Expulsion of dummy transmitters by rainbow trout. Transactions of the American Fisheries Society. 114:766-767.

CHSRG (California Hatchery Scientific Review Group). 2012. California Hatchery Review Report – Appendix VIII: Coleman National Fish Hatchery Steelhead Program Report. Prepared for the US Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. Available at: California Hatchery Review Project Appendix VIII - Coleman NFH steelhead program report

Coble, D. W. 1967. Effects of fin-clipping on mortality and growth of yellow perch with a review of similar investigations. Journal of Wildlife Management 31:173-180.

Conner, W. P., H. L. Burge, and R. Waitt. 2001. Snake River fall Chinook salmon early life history, condition, and growth as affected by dams. Unpublished report prepared by the U.S. Fish and Wildlife Service and University of Idaho, Moscow, ID. 4 p.

Cowen, L. 2007. Effects of angling on chinook salmon for the Nicola River, British Columbia, 1996-2002. North Americana Journal of Fisheries Management 27:256-267.

Cox-Rogers, S., T. Gjernes, and E. Fast. 1999. Canadian Stock Assessment Secretariat Research Document 99/127. Fisheries and Oceans Canada. 16 p.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. Evolutionary Applications. 1(2):252-270.

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. The American Naturalist. 178(6):755-773.

Cuo, L., D. P. Lettenmaier, M. Alberti, and J. E. Richey. 2009. Effects of a century of land cover and climate change on the hydrology of the Puget Sound basin. Hydrol. Process. 23:907-933.

Dalbey, S. R., T. E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury to long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management. 16:560-569.

Denton, K. 2018. Estimating the 2017 Sockeye Salmon Escapement into Lake Ozette Using an ARIS multi-beam SONAR. K. Denton and Associates, LLC. Sequim, WA. 28 pp.

DFO (Department of Fisheries and Oceans Canada). 2020. 2020 Eulachon Integrated Fisheries Management Plan – Fraser River. Department of Fisheries and Oceans Canada-Pacific Region. 71pp.

DFO (Department of Fisheries and Oceans Canada). 2011. Regional Science Advisory Process on the Pacific Review of Yelloweye Rockfish (*Sebastes ruberrimus*), September 22, 2010. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/011. iv + 16 pages.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. Geophysical Research Letters. 39(5). DOI:10.1029/2011GL050762.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science. 4:11-37.

Drake J. S., E. A. Berntson, J. M. Cope, R. G. Gustafson, E. E. Holmes, P. S. Levin, N. Tolimieri, R. S. Waples, S. M. Sogard, and G. D. Williams. 2010. Status review of five rockfish species in Puget Sound, Washington: bocaccio (*Sebastes paucispinis*), canary rockfish (*S. pinniger*), yelloweye rockfish (*S. ruberrimus*), greenstriped rockfish (*S. elongatus*), and redstripe rockfish (*S. proriger*). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-108, 234 pp.

Dwyer, W. P. and R. G. White. 1997. Effect of electroshock on juvenile Arctic grayling and Yellowstone cutthroat trout growth 100 days after treatment. North American Journal of Fisheries Management. 17:174-177.

Feely, R. A., T. Klinger, J. A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Fletcher, D. H., F. Haw, and P. K. Bergman. 1987. Retention of coded-wire tags implanted into cheek musculature of largemouth bass. North American Journal of Fisheries Management 7:436-439.

Ford, M. J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Depart. of Commer., NOAA Tech. Memo. NOAA-TM-NWFSC-113, 281 pp.

Ford, M. J. 2013. Status review update of Southern Resident killer whales. U.S. Dept. of Commerce, Northwest Fisheries Science Center.41p. Available at (Accessed July 2015): Status review update of Southern Resident killer whales weblink

Fredenberg, W. A. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife and Parks, Helena.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

Goode, J. R., J. M. Buffington, D. Tonina D. J. Isaak, R. F. Thurow, S. Wenger, D. Nagel, C. Luce, D. Tetzlaff, and C. Soulsby. 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. Hydrological Processes 27(5):750-765.

Griffith, J., M. Alexandersdottir, R. Rogers, J. Drotts, and P. Stevenson. 2004. 2003 annual Stillaguamish smolt report. Stillaguamish Tribe of Indians.

Gustafson, R., Y.-W. Lee, E. Ward, K. Somers, V. Tuttle, and J. Jannot. 2016. Status review update of eulachon (*Thaleichthys pacificus*) listed under the Endangered Species Act: southern distinct population segment. 25 March 2016 Report to National Marine Fisheries Service – West Coast Region from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.

Haggerty, M. J., A. C. Ritchie, J. G. Shellberg, M. J. Crewson, and J. Jalonen. 2009. Lake Ozette Sockeye Limiting Factors Analysis. Prepared for the Makah Indian Tribe and NOAA Fisheries in Cooperation with the Lake Ozette Sockeye Steering Committee, Port Angeles, WA.

Hallacher, L. E. 1974. The comparative morphology of extrinsic gas bladder musculature in the scorpionfish genus, *Sebastes* (Pisces: *Scorpaenidae*). Proceedings of the California Academy of Sciences. 40(3):59–86.

Hannah, R. W. and K. M. Matteson. 2007. Behavior of nine species of Pacific rockfish after hook-and-line capture, recompression, and release. Transactions of the American Fisheries Society 136:24–33.

Hannah, R. W., S. J. Parker, and K. M. Matteson. 2008. Escaping the surface: the effects of capture depth on submergence success of surface-released Pacific rockfish. North American Journal of Fisheries Management 28:694–700.

Hanson, M. B., K. L. Ayres, R. W. Baird, K. C. Balcomb, K. Balcomb-Bartok, J. R. Candy, C. K. Emmons, J. K. B. Ford, M. J. Ford, B. Gisborne, J. Hempelmann-Halos, G. S. Schorr, J. G. Sneva, D. M. Van Doornik, and S. K. Wasser. 2010a. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. Endangered Species Research. 11:69–82.

Hanson, B., J. Hempelmann-Halos, and D. Van Doornik. 2010b. Species and stock identification of scale/tissue samples from southern resident killer whale predation events collected off the Washington coast during PODs 2009 cruise on the McArthur II, March 16, 2010. Unpublished memorandum

Hay, D. E., P. B. McCarter, R. Joy, M. Thompson, and K. West. 2002. Fraser River Eulachon Biomass Assessments and Spawning Distribution: 1995-2002. Canadian Science Advisory Secretariat Research Document 2002/117. 58pp.

Healey, M. C., and W. Ra Heard. 1984. Inter- and intra-population variation in the fecundity of chinook salmon (*Oncorhynchus tshawytscha*) and its relevance to life history theory. Can. J. Fish. Aquat. Sci. 4l:474-483.

Healey, M. C. 1991. The life history of Chinook salmon (*Oncorhynchus tshawytscha*). *In* C. Groot and L. Margolis (eds), Life history of Pacific salmon, p. 311-393. Univ. BC Press.

Hollender, B. A. and R. F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management. 14:643-649.

HCCC (Hood Canal Coordinating Council). 2005. Hood Canal & Eastern Strait of Juan de Fuca summer chum salmon recovery plan. Hood Canal Coordinating Council. Poulsbo, Washington.

Hochhalter S. J. and D. J. Reed. 2011. The effectiveness of deepwater release at improving the survival of discarded yelloweye rockfish. North American Journal of Fisheries Management 31:852-860.

Hockersmith, E. E., W. D. Muir , S. G. Smith , B. P Sanford , N. S. Adams , J. M. Plumb, R. W. Perry, and D. W. Rondorf. 2000. Comparative performance of sham radiotagged and PIT-tagged juvenile salmon. Report to U.S. Army Corps of Engineers, Contract W66Qkz91521282, 25 p.

Hooton, R. S. 1987. Catch and release as a management strategy for steelhead in British Columbia. *In* R. Barnhart and T. Roelofs, editors. Proceedings of Catch and Release Fishing: a Decade of Experience, a National Sport Fishing Symposium. Humboldt State University, Arcata, California.

Howe, N. R. and P. R. Hoyt. 1982. Mortality of juvenile brown shrimp *Penaeus aztecus* associated with streamer tags. Transactions of the American Fisheries Society. 111:317-325.

Huhn, D. and R. Arlinghaus. 2011. Determinants of hooking mortality in freshwater recreational fisheries: a quantitative meta-analysis. *In* The angler in the environment: social, economic, biological, and ethical dimensions: proceedings of the 5th World Recreational Fishing Conference, number 75 in American Fisheries Society symposium. American Fisheries Society, Bethesda, Md.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Climate Change Report, ISAB 2007-2, Northwest Power and Conservation Council, Portland, Oregon.

Isaak, D. J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. Climatic Change. 113(2):499-524.

Jarvis, E. T., and C. G. Lowe. 2008. The effects of barotrauma on the catch-and-release survival of southern California nearshore and shelf rockfish (*Scorpaenidae*, *Sebastes* spp.). Canadian Journal of Fisheries and Aquatic Sciences 65:1286–1296.

Jenkins, W. E. and T. I. J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. American Fisheries Society Symposium 7:341-345.

Kamler, J. F. and K. L. Pope. 2001. Nonlethal Methods of Examining Fish Stomach Contents. Reviews in Fisheries Science. 9(1):1-11.

Kier, M.C., J. Hileman, and S. Cannata. 2015. Annual Report Trinity River Basin Salmon and Steelhead Monitoring Project.

Kohlhorst, D. W. 1979. Effect of first pectoral fin ray removal on survival and estimated harvest rate of white sturgeon in the Sacramento-San Joaquin estuary. California Department of Fish and Game. 65: 173-177.

Krahn, M. M., P. R. Wade, S. T. Kalinowski, M. E. Dahlheim, B. L. Taylor, M. B. Hanson, G. M. Ylitalo, R. P. Angliss, J. E. Stein, and R. S. Waples. 2002. Status review of southern resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC54, U.S. Department of Commerce, Seattle, Washington.

Krahn, M. M., M. B. Hanson, R. W. Baird, R. H. Boyer, D. G. Burrows, C. E. Emmons, J. K. B. Ford, L. L. Jones, D. P. Noren, P. S. Ross, G. S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin. 54:1903-1911.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Langness, O. P., L. L. Lloyd, S. M. Schade, B. J. Cady, L. B. Heironimus, P. E. Dionne, and A. M. Claiborne. 2020. Status of Eulachon in Washington: Annual Report July 2018 - July 2019. Fish Program Report Number FPA 20-03, February 27, 2020. Washington Department of Fish and Wildlife. Olympia, WA. 103pp.

Langness, O. 2018. NOAA 2014 Protected Species Studies of Eulachon in Oregon and Washington designed to guide implementation of a monitoring program to track coast-wide status and trends in abundance and distribution - Reporting Period: January 1, 2018 to June 30, 2018. Washington Department of Fish and Wildlife. Vancouver, WA. 76pp.

Lawson, P. W., E. A. Logerwell, N. J. Mantua, R. C. Francis, and V. N. Agostini. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences. 61(3):360-373

Lewis, M., E. Brown, B. Sounhein, M. Weeber, E. Suring, and H. Truemper. 2009. Status of Oregon stocks of coho salmon, 2004 through 2008. Monitoring Program Report Number OPSW-ODFW-2009-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., B. Sounhein, M. Weeber, and E. Brown. 2010. Status of Oregon stocks of coho salmon, 2009. Monitoring Program Report Number OPSW-ODFW-2010-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., M. Weeber, E. Brown, and B. Sounhein. 2011. Status of Oregon stocks of coho salmon, 2010. Monitoring Program Report Number OPSW-ODFW-2011-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., E. Brown, B. Sounhein, and M. Weeber. 2012. Status of Oregon stocks of coho salmon, 2011. Monitoring Program Report Number OPSW-ODFW-2012-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., B. Sounhein, M. Weeber and E. Brown. 2014. Status of Oregon stocks of coho salmon, 2012. Monitoring Program Report Number OPSW-ODFW-2013-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Light, R. W., P. H. Adler, and D. E. Arnold. 1983. Evaluation of Gastric Lavage for Stomach Analyses. North American Journal of Fisheries Management. 3:81-85.

Lindsay, R. B., R. K. Schroeder, and K. R. Kenaston. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. North American Journal of Fisheries Management 24:367-378.

Love, M. S., M. Carr, and L. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus Sebastes. Environmental Biology of Fishes. 30:225-243.

Love, M. S., M. M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the Northeast Pacific. University of California Press, Berkeley, California.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *in* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, M. M. Elsner, J. Littell, and L. Whitely Binder, Eds. The Climate Impacts Group, University of Washington, Seattle, Washington, pp. 217-253.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change. 102(1):187-223.

Matthews, K. R. and R. H. Reavis. 1990. Underwater tagging and visual recapture as a technique for studying movement patterns of rockfish. American Fisheries Society Symposium. 7:168-172.

Mattole Salmon Group. 2011. Spawning Ground Surveys, 2010-2011 Season Mattole River Watershed – Final Report. Petrolia, CA. 41 pp.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo NMFS-NWFSC-42. 156pp.

McMahon, T. E. and G. F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences. 46:1551-1557.

McMichael, G. A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13:229-233.

McMichael, G. A., L. Fritts, and T. N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management. 18:894-904.

McNeil, F. I. and E. J. Crossman. 1979. Fin clips in the evaluation of stocking programs for muskellunge (*Esox masquinongy*). Transactions of the American Fisheries Society. 108:335-343.

McPherson, S. and J. C. Woodey. 2009. Cedar River and Lake Washington Sockeye Salmon Biological Reference Point Estimates. Prepared for Washington Department of Fisheries and Wildlife. Olympia, WA. 62pp.

Mears, H. C. and R. W. Hatch. 1976. Overwinter survival of fingerling brook trout with single and multiple fin clips. Transactions of the American Fisheries Society 105: 669-674.

Meehan, W.R. and R.A. Miller. 1978. Stomach flushing: effectiveness and influence on survival and condition of juvenile salmonids. J. Fish. Res. Board Can. 35:1359-1363.

Mellas, E. J. and J. M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): effects of attaching telemetry transmitters. Canadian Journal of Fisheries and Aquatic Sciences 42:488-493.

Metheny, M., and W. Duffy. 2014. Sonar estimation of adult salmonid abundance in Redwood Creek, Humboldt County, California 2012-2013. Report for California Department of Fish and Wildlife Fisheries Restoration Grants Program.

Meyer, J. L., M. J. Sale, P. J. Mulholland, and N. L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. JAWRA Journal of the American Water Resources Association. 35(6):1373-1386.

Mongillo, P. E. 1984. A summary of salmonid hooking mortality. Washington Department of Game, Olympia.

Mora, E. A., R. D. Battleson, S. T. Lindley, M. J. Thomas, R. Bullmer, L. J. Zarri, and A. P. Klimley. 2018. Estimating the Annual Spawning Run Size and Population Size of the Southern Distinct Population Segment of Green Sturgeon. Transactions of the American Fisheries Society. 147:195-203.

Moring, J. R. 1990. Marking and tagging intertidal fishes: review of techniques. American Fisheries Society Symposium. 7:109-116.

Morrison, J. and D. Zajac. 1987. Histologic effect of coded wire tagging in chum salmon. North American Journal of Fisheries Management 7:439-441.

Mote, P. W., J. Abatzoglou, and K. Kunkel. 2013. Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. Island Press, 224 pp.

Mote, P. W, A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. R. Raymondi, and W. S. Reeder. 2014. Ch. 21: Northwest. *in* Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, pp. 487-513.

Mote, P. W., D. E. Rupp, S. Li, D. J. Sharp, F. Otto, P. F. Uhe, M. Xiao, D. P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States. Geophysical Research Letters. 43:10980-10988. doi:10.1002/2016GLO69665

Moulton, L. L. and B. S. Miller. 1987. Characterization of Puget Sound marine fishes: survey of available data. Fisheries Research Institute, School of Fisheries, University of Washington. FRI-UW 8716.

Muoneke, M. and W. M. Childress. 1994. Hooking Mortality: A Review for Recreational Fisheries. Reviews in Fisheries Science. 2:123-156.

Nelson, T., M. Rosenau, and N. T. Johnston. 2005. Behavior and Survival of Wild and Hatchery-Origin Winter Steelhead Spawners Caught and Released in a Recreational Fishery. North American Journal of Fisheries Management. 25(3):931-943.

Nickelson, T.E. 1998. A Habit-Based Assessment of Coho Salmon Production Potential and Spawner Escapement Needs for Oregon Coastal Streams. INFORMATION REPORTS NUMBER 98-4. Oregon Department of Fish and Wildlife. April, 1998.

Nicola, S. J. and A. J. Cordone. 1973. Effects of fin removal on survival and growth of rainbow trout (*Salmo gairdneri*) in a natural environment. Transactions of the American Fisheries Society. 102(4):753-759.

Nielsen, L. A. 1992. Methods of marking fish and shellfish. American Fisheries Society Special Publication 23. Bethesda, Maryland.

NMFS (National Marine Fisheries Service). 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act, June 2000. Available at: NOAA Fisheries Guidelines for Electrofishing Waters webpage

NMFS (National Marine Fisheries Service). 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Protected Resources Division, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006. Final supplement to the Puget Sound Salmon Recovery Plan. Available at: Final supplement to PS Salmon Recovery Plan weblink

NMFS (National Marine Fisheries Service). 2007. Final Supplement to the recovery plan for the Hood Canal and eastern Strait of Juan de Fuca summer chum salmon (*Oncorhynchus keta*). National Marine Fisheries Service, Northwest Region. Portland, Oregon

NMFS (National Marine Fisheries Service). 2008. Recovery plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2009a. Recovery Plan For Lake Ozette Sockeye Salmon (*Oncorhynchus nerka*). National Marine Fisheries Service, West Coast Region, Portland, OR. 394 pp.

NMFS (National Marine Fisheries Service). 2009b. Middle Columbia Steelhead ESA Recovery Plan. National Marine Fisheries Service, West Coast Region, Portland, OR. 260 pp.

NMFS (National Marine Fisheries Service). 2012. Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.

NMFS (National Marine Fisheries Service). 2013. ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and

Lower Columbia River Steelhead. National Marine Fisheries Service, West Coast Region, Portland, OR. 503 pp.

NMFS (National Marine Fisheries Service). 2014a. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. California Central Valley Area Office. July 2014.

NMFS (National Marine Fisheries Service). 2014b. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service. Arcata, CA. 406 pp.

NMFS (National Marine Fisheries Service). 2015a. ESA Recovery Plan for Snake River Sockeye Salmon (*Oncorhynchus nerka*). National Marine Fisheries Service, West Coast Region, Portland, OR. 431 pp.

NMFS (National Marine Fisheries Service). 2015b. Southern Distinct Population Segment of the North American Green Sturgeon (*Acipenser medirostris*) – 5-Year Review: Summary and Evaluation. National Marine Fisheries Service. Long Beach, CA. 42 pp.

NMFS (National Marine Fisheries Service). 2016a. Coastal Multispecies Recovery Plan. National Marine Fisheries Service, West Coast Region, Santa Rosa, California.

NMFS (National Marine Fisheries Service). 2016b. Final ESA Recovery Plan for Oregon Coast Coho Salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service, West Coast Region, Portland, OR. 230 pp.

NMFS (National Marine Fisheries Service). 2016c. Yelloweye rockfish (*Sebastes ruberrimus*), canary rockfish (*Sebastes pinniger*) and bocaccio (*Sebastes paucispinis*) of the Puget Sound/Georgia Basin – 5-Year Review: Summary and Evaluation. National Marine Fisheries Service. Seattle, WA. 131 pp.

NMFS (National Marine Fisheries Service). 2016d. 2016 5-Year Review: Summary & Evaluation of Ozette Lake Sockeye. NMFS, West Coast Region. Portland, OR. 47 pp.

NMFS (National Marine Fisheries Service). 2017a. ESA Recovery Plan for Snake River Fall Chinook Salmon (*Oncorhynchus tshawytscha*). National Marine Fisheries Service, West Coast Region, Portland, OR. 366 pp.

NMFS (National Marine Fisheries Service). 2017b. ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon (*Oncorhynchus tshawytscha*) & Snake River Basin Steelhead (*Oncorhynchus mykiss*). National Marine Fisheries Service, West Coast Region, Portland, OR. 284 pp.

NMFS (National Marine Fisheries Service). 2017c. Endangered Species Act Recovery Plan for the Southern Distinct Population Segment of Eulachon (*Thaleichthys pacificus*). National Marine Fisheries Service, West Coast Region, Portland, OR. 132 pp.

NMFS (National Marine Fisheries Service). 2017d. Rockfish Recovery Plan: Puget Sound / Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*Sebastes paucispinis*). National Marine Fisheries Service. Seattle, WA. 167 pp.

NMFS (National Marine Fisheries Service). 2018a. Proposed Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). National Marine Fisheries Service. Seattle, WA. 291 pp.

NMFS (National Marine Fisheries Service). 2018b. Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). National Marine Fisheries Service, Sacramento, CA. 95 pp.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. 357 pp.

ODFW (Oregon Department of Fish and Wildlife). 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. August, 2011.

ODFW (Oregon Department of Fish and Wildlife). 2017. Umpqua River Basin Coho Salmon Program - South Umpqua River/Cow Creek Coho Salmon Hatchery and Genetic Management Plan (HGMP). 64 pp.

ODFW (Oregon Department of Fish and Wildlife) and NMFS (National Marine Fisheries Service). 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. 462 pp.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2014. 2014 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. January 22, 2014.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2015. 2015 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. January 21, 2015.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2016. 2016 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. January 20, 2016.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2017. 2017 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species. Joint Columbia River

Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. November 9, 2017.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2018. 2018 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. February 20, 2018.

Olander, D. 1991. Northwest Coastal Fishing Guide. Frank Amato Publications, Portland, Oregon.

Palsson, W. A., T.-S. Tsou, G. G. Bargmann, R. M. Buckley, J. E. West, M. L. Mills, Y. W. Cheng, and R. E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound. FPT 09-04. Washington Dept. Fish and Wildlife, Olympia.

Parker, S. J., H. I. McElderry, P. S. Rankin, and R.W. Hannah. 2006. Buoyancy regulation and barotrauma in two species of nearshore rockfish. Transactions of the American Fisheries Society 135:1213–1223.

Pauley, G. B., B. M. Bortz, and M. F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- steelhead trout. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.62). U.S. Army Corps of Engineers, TR EL-82-4. 24 pp.

Peltz, L. and J. Miller. 1990. Performance of half-length coded wire tags in a pink salmon hatchery marking program. American Fisheries Society Symposium 7:244-252.

Pettit, S. W. 1977. Comparative reproductive success of caught-and-released and unplayed hatchery female steelhead trout (*Salmo gairdneri*) from the Clearwater River, Idaho. Transactions of American Fisheries Society. 106(5):431-435.

PFMC (Pacific Fishery Management Council). 2013. Appendix B, Historical Record of Escapement to Inland Fisheries and Spawning Areas. Review of 2012 Ocean Salmon Fisheries (Document prepared for the Council and its advisory entities.) Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, OR 97220-1384.

PFMC (Pacific Fishery Management Council). 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. 227 pp.

Prentice, E. F. and D. L. Park. 1984. A study to determine the biological feasibility of a new fish tagging system. Annual Report of Research, 1983-1984. Project 83-19, Contract DEA179-83BP11982.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Bonneville Power Administration, Portland, Oregon.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7: 317-322.

Pribyl, A. L., C. B. Schrek, M. L. Kent, and S. J. Parker. 2009. The differential response to decompression of three species of nearshore Pacific rockfish. North American Journal of Fisheries Management 29:1479–1486.

Pribyl A. L., M. L. Kent, S. J. Parker, and C. B. Schreck. 2011. The response to forced decompression in six species of pacific rockfish. Transactions of the American Fisheries Society 140:374–383.

Quinn, T. P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. Published by University of Washington Press. 2005. 378 pp.

Raymondi, R. R., J. E. Cuhaciyan, P. Glick, S. M. Capalbo, L. L. Houston, S .L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation *in* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, M. M. Dalton, P. W. Mote, and A. K. Snover, Eds., Island Press, Washington, DC, pp. 41-58.

Reeder, W. S., P. R. Ruggiero, S. L. Shafer, A. K. Snover, L. L Houston, P. Glick, J. A. Newton, and S. M. Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. *in* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, M. M. Dalton, P. W. Mote, and A. K. Snover, Eds. Island Press, Washington, DC, pp 41-58.

Reingold, M. 1975. Effects of displacing, hooking, and releasing on migrating adult steelhead trout. Transactions of the American Fisheries Society. 104(3):458-460.

Ricker, S.J , D. Ward, and C.W. Anderson. 2014. Results of Freshwater Creek Salmonid Life Cycle Monitoring Station 2010-2013. California Department of Fish and Game, Anadromous Fisheries Resource Assessment and Monitoring Program, 50 Ericson Ct., Arcata, CA 95521.

Rogers, B. L., C. G. Lowe, E. Fernandez-Juricic, and L. R. Frank. 2008. Utilizing magnetic resonance imaging (MRI) to assess the effects of angling-induced barotrauma on rockfish (*Sebastes*). Canadian Journal of Fisheries and Aquatic Sciences 65:1245-1249.

Rondorf, D. W. and W. H. Miller. 1994. Identification of the spawning, rearing and migratory requirements of fall Chinook salmon in the Columbia River Basin. Prepared for the U.S. Dept. of Energy, Portland, OR. 219 p.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). In Pacific salmon life histories. Edited by C. Root and L. Marolis. UBC Press, Vancouver, BC. pp. 296 – 445.

Scheuerell, M. D. and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography. 14:448-457.

Schill, D. J., and R. L. Scarpella. 1995. Wild trout regulation studies. Annual performance report. Idaho Department of Fish and Game, Boise.

Schisler, G. J. and E. P. Bergersen. 1996. Post release hooking mortality of rainbow trout caught on scented artificial baits. North American Journal of Fisheries Management. 16(3):570-578.

Scholz, N. L., M. S. Myers, S. G. McCarthy, J. S. Labenia, J. K. McIntyre, G. M. Ylitalo, L. D. Rhodes, C. A. Laetz, C. M. Stehr, B. L. French, B. McMillan, D. Wilson, L. Reed, K. D. Lynch, S. Damm, J. W. Davis, and T. K. Collier. 2011. Recurrent die-offs of adult coho salmon returning to spawn in Puget Sound lowland urban streams. PLos One. 6(12):1-12

Schroeder, R. K., K. R. Kenaston, and R. B. Lindsay. 2000. Spring Chinook salmon in the Willamette and Sandy Rivers. October 1998 through September 1999. Annual progress report, Fish Research Project Oregon. Oregon Department of Fish and Wildlife, Portland.

Seiler, D., G. Volkhardt, P. Topping, and L. Kishimoto. 2002. 2000 Green River juvenile salmonid production evaluation. Washington Department of Fish and Wildlife.

Seiler, D., G. Volkhardt, P. Topping, L. Fleischer, T. Miller, S. Schonning, D. Rawding, M. Groesbeck, R. Woodard, and S. Hawkins. 2004. 2003 juvenile salmonid production evaluation report. Green River, Wenatchee River, and Cedar Creek. Washington Department of Fish and Wildlife.

Seiler, D., G. Volkhardt, and L. Fleischer. 2005. Evaluation of downstream migrant salmon production in 2004 from the Cedar River and Bear Creek. Washington Department of Fish and Wildlife.

Sharber, N. G. and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management. 8:117-122.

Sharber, N. G., S. W. Carothers, J. P. Sharber, J. C. DeVos, Jr., and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management. 14:340-346.

Sharpe, C. S., D. A. Thompson, H. L. Blankenship, and C. B. Schreck. 1998. Effects of routine handling and tagging procedures on physiological stress responses in juvenile Chinook salmon. Progressive Fish-Culturist. 60(2):81-87.

Snyder, D. E. 1995. Impacts of electrofishing on fish. Fisheries. 20(1):26-27.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2014. Status of Oregon stocks of coho salmon, 2013. Monitoring Program Report Number OPSW-ODFW-2014-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2015. Status of Oregon stocks of coho salmon, 2014. Monitoring Program Report Number OPSW-ODFW-2015-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2016. Status of Oregon stocks of coho salmon, 2015. Monitoring Program Report Number OPSW-ODFW-2016-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2017. Status of Oregon stocks of Coho Salmon, 2016. Monitoring Program Report Number OPSW-ODFW-2017-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2018. Western Oregon adult Coho Salmon, 2017 spawning survey data report. Monitoring Program Report Number OPSW-ODFW-2018-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

SSDC (Shared Strategy Development Committee). 2007. Puget Sound Salmon Recovery Plan. Adopted by the National Marine Fisheries Service January 19, 2007. Available on-line at PS Salmon Recovery Plan weblink

Stanley, R.D., M. McAllister, and P. Starr. 2012. Updated stock assessment for bocaccio (*Sebastes paucispinis*) in British Columbia waters for 2012. DFO Canadian Scientific Advisory Secretariat Research Document 2012/109. 73pp.

Starr, R. M., J. N. Heine, J. M. Felton, and G. M. Cailliet. 2002. Movements of bocaccio (*Sebastes paucispinis*) and greenspotted (*S. chlorostictus*) rockfishes in a Monterey submarine canyon: implications for the design of marine reserves. U.S. National Marine Fisheries Service Fishery Bulletin 100:324–337.

Stolte, L. W. 1973. Differences in survival and growth of marked and unmarked coho salmon. Progressive Fish-Culturist 35: 229-230.

Stout, H.A., P.W. Lawson, D. Bottom, T. Cooney, M. Ford, C. Jordan, R. Kope, L. Kruzic, G.Pess, G. Reeves, M. Scheuerell, T. Wainwright, R. Waples, L. Weitkamp, J. Williams and T. Williams. 2011. Scientific conclusions of the status review for Oregon Coast coho salmon (*Oncorhynchus kisutch*). Draft revised report of the Oregon Coast Coho Salmon Biological Review Team. NOAA/NMFS/NWFSC, Seattle, WA.

Strange, C. D. and G. J. Kennedy. 1981. Stomach flushing of salmonids: a simple and effective technique for the removal of the stomach contents. Fish. Manage. 12:9-15.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. Environmental Science & Technology. 46(19):10651-10659.

TAC [TAC (U.S. v. Oregon Technical Advisory Committee)]. 2008. Biological assessment of incidental impacts on salmon species listed under the Endangered Species Act in the 2008-2017 non-Indian and treaty Indian fisheries in the Columbia River Basin.

Tague, C. L., J. S. Choate, and G. Grant. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrology and Earth System Sciences. 17(1): 341-354.

Taylor, G. and R. A. Barnhart. 1999. Mortality of angler caught and released steelhead. California Cooperative Fish and Wildlife Research Unit, Arcata.

Taylor, M. J. and K. R. White. 1992. A meta-analysis of hooking mortality of non-anadromous trout. North American Journal of Fisheries Management. 12:760-767.

Thompson, K. G., E. P. Bergersen, R. B. Nehring, and D. C. Bowden. 1997. Long-term effects of electrofishing on growth and body condition of brown and rainbow trout. North American Journal of Fisheries Management. 17:154-159.

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

Tolimieri, N. and P. S. Levin. 2005. The roles of fishing and climate in the population dynamics of bocaccio rockfish. Ecological Applications 15:458-468.

USDC (United States Department of Commerce). 2009. Endangered and threatened wildlife and plants: final rulemaking to designate critical habitat for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(195):52300-52351.

USFWS (United States Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. U.S. Fish &Wildlife Service and National Marine Fisheries Service.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. 352 pp.

Volkhardt, G., P. Topping, L. Fleischer, T. Miller, S. Schonning, D. Rawding, M. Groesbeck. 2005. 2004 Juvenile salmonid production evaluation report. Green River, Wenatchee River, and Cedar Creek. Washington Department of Fish and Wildlife.

Wainwright, T. C. and L. A. Weitkamp. 2013. Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Science. 87:219-242.

Wallace, J. R. 2007. Update to the status of yelloweye rockfish (*Sebastes ruberrimus*) off the U.S. West Coast in 2007, Pacific Fishery Management Council, Portland, OR.

Waples, R. S. 1991. Definition of "Species" under the Endangered Species Act: Application to Pacific Salmon. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS, F/NWC-194. 29 pp.

Ward, B. R. and P. A. Slaney. 1993. Egg-to-smolt survival and fry-to-smolt density dependence in Keogh River steelhead trout, p. 209-217. *In* R. J. Gibson and R. E. Cutting [ed.] Production of juvenile Atlantic salmon, *Salmon salar*, in natural waters. Can. Spec. Publ. Fish. Aquat. Sci. 118.

WDFW (Washington Department of Fish and Wildlife). 2017. Draft conservation plan for reducing the impact of selected fisheries on ESA listed species in Puget Sound, with an emphasis on bocaccio and yelloweye rockfish. Prepared for the National Marine Fisheries Service by the Washington Department of Fish and Wildlife.

WDFW/PNPTT (Washington Department of Fish and Wildlife and Point No Point Treaty Tribes). 2000. Summer chum salmon conservation initiative. Washington Department of Fish and Wildlife, Olympia.

Welch, H.E. and K. H. Mills. 1981. Marking fish by scarring soft fin rays. Canadian Journal of Fisheries and Aquatic Sciences 38:1168-1170.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L.G. Crozier, N.J. Mantua, M.R. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-564.

Winder, M. and D. E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology. 85:2100–2106.

Wissmar, R. C., J. E. Smith, B. A. McIntosh, H. W. Li, G. H. Reeves, and J. R. Sedell. 1994. Ecological Health of River Basins in Forested Regions of Eastern Washington and Oregon. Gen. Tech. Rep. PNW-GTR-326. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. Portland, OR. 65 p.

Wydoski, R. S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management. Pages 43-87 in R.A. Barnhart and T.D. Roelofs, editors. Proceedings of a national symposium on catch-and-release fishing as a management tool. Humboldt State University, Arcata, California.

Yamanaka, K. L. and A. R. Kronlund. 1997. Inshore rockfish stock assessment for the West Coast of Canada in 1996 and recommended yields for 1997. Can. Tech. Rep. Fish. Aquat. Sci. 2175:1-80.

Yamanaka, K. L., L. C. Lacko, R. Witheler, C. Grandin, J. K. Lochead, J.-C. Martin, N. Olsen, and S. S. Wallace. 2006. A review of yelloweye rockfish *Sebastes ruberimus* along the Pacific coast of Canada: biology, distribution, and abundance trends. Research Document 2006/076. Fisheries and Oceans Canada. 54pp.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology. 20(1):190-200.

Zabel, R. W. 2014. Memorandum to Donna Weiting: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2014. Northwest Fisheries Science Center. November 4, 2014.

Zabel, R. W. 2015. Memorandum to Donna Weiting: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2015. Northwest Fisheries Science Center. October 5, 2015.

Zabel, R. W. 2017a. Memorandum for Christopher E. Yates: Update, Corrected Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2016. Northwest Fisheries Science Center. January 25, 2017.

Zabel, R. W. 2017b. Memorandum for Chris Yates: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2017. Northwest Fisheries Science Center. November 3, 2017.

Zabel, R. W. 2018. Memorandum for Chris Yates: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2018. Northwest Fisheries Science Center. December 18, 2018.

Zabel, R. W. 2020. Memorandum for Chris Yates: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2019. Northwest Fisheries Science Center. February 13, 2020.